

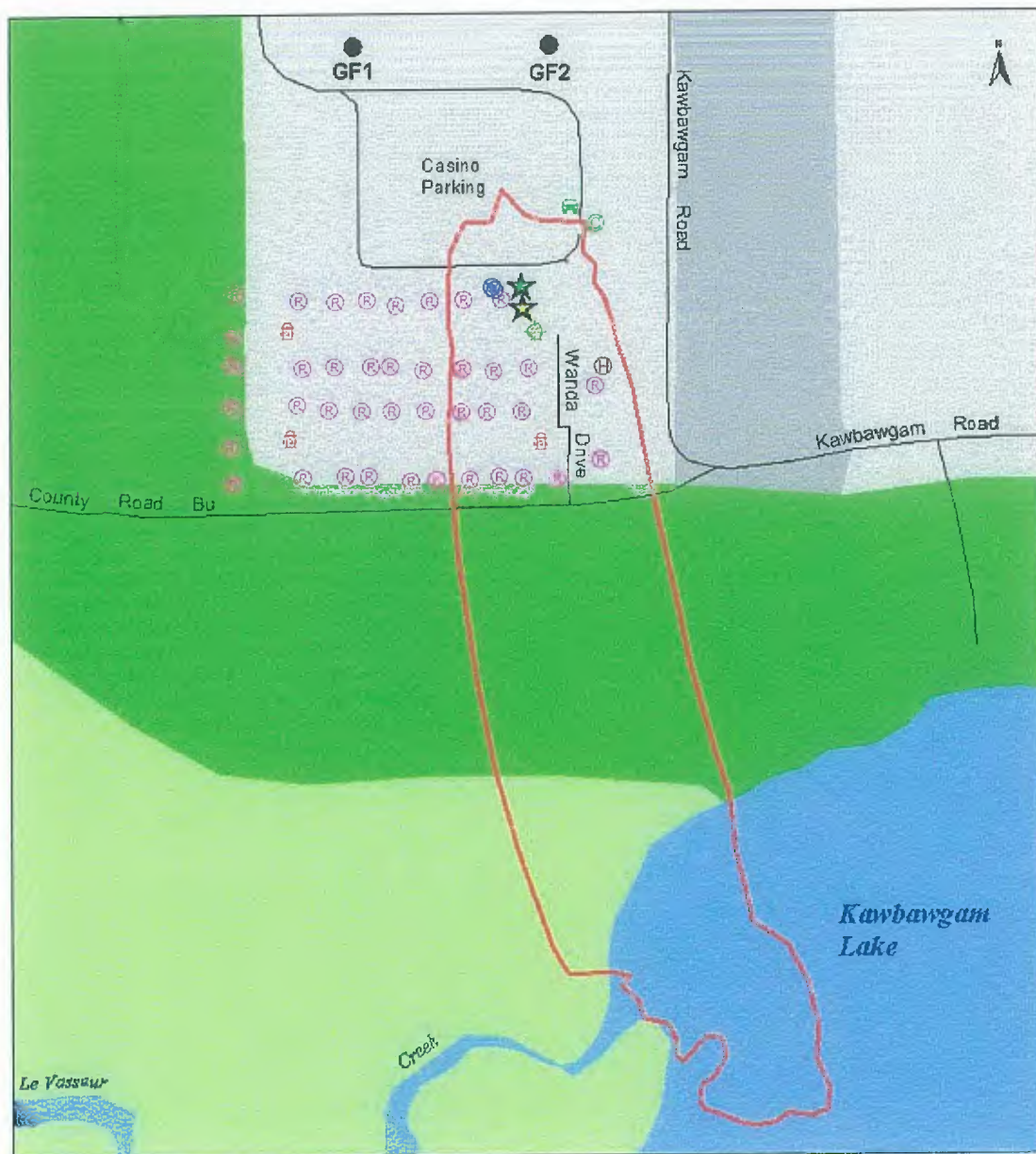
## **APPENDIX H:**

Source Water Assessment and Protection Plans; Kawbawgam Road and Zeba

# Kawbawgam Road Public Water Supply Source Water Assessment and Protection Plan

Keweenaw Bay Indian Community

By M.K. Slis and T.L. Weaver



## **TABLE OF CONTENTS**

INTRODUCTION TO SOURCE WATER PROTECTION OF GROUND-WATER SOURCES .....	3
<i>B.1 ASSESSMENT AND PUBLIC PARTICIPATION</i> .....	4
WORKSHEET 1 Public Participation .....	4
WORKSHEET 2 Management Group .....	4
WORKSHEET 3 Mission Statement .....	7
WORKSHEET 4 WHPA Delineation .....	8
WORKSHEET 5 Drinking Water Source Location .....	8
<i>B.2 WHPA DELINEATION</i> .....	8
Ground-water flow model prepared for WHPA delineation .....	8
<i>B.3 CONTAMINANT INVENTORY</i> .....	11
WORKSHEET 9 RECORDS REVIEW FOR CONTAMINANT INVENTORY .....	11
Potential contaminant sources in the Kawbawgam Road wellhead protection area .....	12
WORKSHEET 10 WINDSHIELD SURVEY .....	12
WORKSHEET 12 ABANDONED WELL SURVEY .....	13
WORKSHEET 13 P.C.I.: Naturally Occurring Sources .....	14
WORKSHEET 13 Agricultural and Logging Sources .....	14
WORKSHEET 13 Residential Sources .....	15
WORKSHEET 13 Municipal Sources .....	16
WORKSHEET 13 Commercial Sources .....	17
WORKSHEET 13 Industrial Sources .....	20
WORKSHEET 13 Industrial Processes .....	21
<i>B.4 SUSCEPTIBILITY DETERMINATION</i> .....	22
Historical Contaminant Detections .....	23
<i>C.1 STRATEGIES FOR PROTECTING DRINKING WATER SOURCES</i> .....	24
Building a Source Water Assessment Protection Program .....	24
Non-regulatory Strategies .....	24
Regulatory Strategies .....	24
Planning for the Future .....	25
WORKSHEET 15 EVALUATION OF MANAGEMENT STRATEGIES .....	25
WORKSHEET 16 SOURCE WATER PROTECTION PROGRAM CHECKUP .....	27
Selected References .....	27

# **Kawbawgam Road Public Water Supply Source Water Assessment and Protection Plan**

## **INTRODUCTION TO SOURCE WATER PROTECTION OF GROUND-WATER SOURCES**

There are several guidance documents identifying strategies for completing a source water assessment and protection plan (SWA&PP) for ground-water supplies. Protecting a ground-water source is often, if not universally, easier than a surface-water supply, such as the Zeba public water supply (PWS), L'Anse Indian Reservation, Baraga County, MI.

Keweenaw Bay Indian Community (KBIC) has been proactive when dealing with water supply issues. In 1999, the U.S. Geological Survey (USGS) developed a wellhead Protection Area (WHPA) delineation for the Kawbawgam Road PWS wells (Weaver and others, 2000), which included a MODFLOW (McDonald and Harbaugh, 1988) model of ground-water flow. The USGS also prepared a source water assessment (SWA) for the Kawbawgam Road PWS wells in November 2002 (Sweat, 2002).

Michigan Department of Environmental Quality (MDEQ) currently requires completion of a WHPA delineation, source water assessment and contingency plans to meet the requirements for a ground-water system SWA&PP (Brad Brogren, oral. commun., 2003). The Michigan Section of the American Water Works Association and the Michigan Water Environment Association issued a joint position statement in September 2001 detailing their interpretation of source water protection (SWP) that are included as appendix 1.

The previous USGS report and MODFLOW model (Weaver, Luukkonen, and Ellis, 2000) and Kawbawgam SWA (Sweat, 2002) are an integral part of the SWA&PP, containing the bulk of scientific information comprising the SWA&PP, and included with this report as appendix 2 and 3, respectively.

### **Protecting Drinking Water: An Example Workbook for Tribes**

KBIC and USGS chose Protecting Drinking Water: A Workbook for Tribes, written by Glenn Totten of the Water Education Foundation and funded by USEPA (version dated July 11, 2000; modified by USEPA Region 5 in November 2000) as a drinking water protection guide. Language in this workbook is similar, if not identical in many sections, to previous documentation provided to Tribes by USEPA. This workbook contains 16 worksheets, which augment information previously gathered during the preparation of the SWA, and collectively form the basis for a SWA&PP that the USEPA is likely to approve. A great deal of information that is contained within the workbook should be updated as necessary to keep the SWA&PP as current as possible. Several worksheets have been omitted for reasons of inapplicability.

## ***B.1 ASSESSMENT AND PUBLIC PARTICIPATION***

### **WORKSHEET 1 Public Participation**

Public participation is broken into 5 subcategories: forming a planning committee; adopting a mission, or mission statement; publicizing activities of the planning and advisory committees; drafting ordinances or codes; and notifying tribal members and leaders of the results of the SWA&PP processes. The first two subcategories have been completed. The SWA has been distributed to the KBIC Housing Department for distribution to all KBIC Housing tenants and will be announced in the local papers for private citizen review in October of 2003. Ordinances, regulations, or codes may follow public notification and would be noted within Worksheet 16, as updates to the plan. Delineation, contaminant inventory, and susceptibility determination were completed as part of SWA.

### **WORKSHEET 2 Management Group**

Worksheet 2 lists members of the team that oversees SWA&PP activities, contact information, and a brief description of how each member will be involved in the SWA&PP activities.

Active groups and/or individuals are listed in the first spreadsheet and secondary groups/individuals are listed in the second spreadsheet. Groups and individuals in the initial list are responsible for maintaining the SWA&PP, and will hereafter be referred to as the Group, while those on the second list play less important roles, such as initial compilation of the SWA&PP. Groups or individuals on the secondary list would be notified about problems with the SWA&PP, or within the source water area, if the initial Group determines that the secondary list groups or individuals need to play a role in efforts to address the problem. Members of the Group will institute provisions and make changes to the contingency plan, if necessary. A contingency plan has been produced as a separate document, complimenting the SWA&PP, and is included as appendix 4.

**Management Group, charged with implementation and maintenance of Kawbawgam SWA&PP**

<b>Groups to be represented</b>	<b>Name, position, and contact information</b>	<b>How will this person be involved?</b>
Program director	Mike Donofrio, KBIC Natural Resources Department Director, 906-524-5757 (ext. 13)	Coordinate Program, ensure that Tribal Groups use best management practices e.g. do not increase development pressure on the current delineated wellhead protection area
Water Quality Specialist	Marc Slis, KBIC Water Quality Specialist 906-524-5757 (ext. 15)	Coordinate Program. Update SWA&PP.
Environmental Specialist	Mike Sladewski, KBIC Environmental Specialist 906-5757 (ext. 14)	Maintain map of SWA/WHPA with updates to PCS list. Assist Group with developing ordinances and codes necessary to protect SWA.
KBIC, Tribal Police Department	Baraga (906) 353-6626	Uphold ordinances or codes adopted by KBIC and Group.
KBIC, Housing Authority	(906) 353-6623	Ensure that development activities pose no threat to SWA/WHPA.
Marquette County Emergency Services Coordinator/Sheriff Department	Marquette County Emergency Services Division, Sheriff's Department (906) 346-4045	Uphold ordinances or codes adopted by Group. Notify Group or KBIC if emergency threatens source water.
Water Plant Operator, Kawbawgam Road Housing Community	Carl, Rasenen, Operator (906) 353-7117	Adjust water treatment plant as necessary to counteract changes in source water quality.

**Secondary group, consisting of non-essential contacts that have either participated in the development of the SWA&PP, or could be contacted for informational purposes.**

<b>Groups to be represented</b>	<b>Name, position, and contact information</b>	<b>How will this person be involved?</b>
U.S. Geological Survey	Tom Weaver, Hydrologist (906) 786-0714	Developed the SWA&PP and contingency plan in conjunction with KBIC Environmental Director and Staff.
Michigan Department of Environmental Quality, Remediation and Redevelopment Division	Clif Clark, District Supervisor, Upper Peninsula District, (906) 346-8515 clarkcg@michigan.gov	Notify KBIC if emergency threatens source water.
Michigan Department of Environmental Quality, Water Division	Chuck Thomas, Geologist, (906) 475-2048	MDEQ Water Division administers the Source Water Protection program for the state and provides oversight for non-Tribal community water supplies.
Marquette County Health Department, Environmental Health	Unknown, Sanitarian (906) 475-4195	Assist with dissemination of group findings to non-Tribal community members.
U.S. Environmental Protection Agency	Chuck Pycha, Tribal Technical Contact (312) 886-0259  Dennis Baker, Michigan Circuit Rider (231) 271-7492	Represent U.S. EPA as necessary, assist group with addendums to SWA&PP as a necessary, as well as assistance with Great Lakes spills, land-based discharges, updating potential contaminant sources list.
Bureau of Indian Affairs	Jim Ruhl, Hydrologist 612-713-4400, Ext. 1068	Represent BIA as necessary. Update SWA&PP as necessary.
Indian Health Service	Sanitarian (Rhineland Office) (715) 365-5120	Represent IHS as necessary, monitor finished and source water quality at Kawbawgam WTP as necessary. Update SWA&PP as necessary.
Water Plant Operator, City of Marquette	Pumping Station (906) 228-0488	Provide City of Marquette water to KBIC on an emergency basis. Need to make arrangements to fill tank trucks if this option is utilized.
Chocolay Township	Randy Yelle, Zoning Supervisor (906) 249-1448	Township contact responsible for zoning compliance within the Lake Kawbawgam watershed

### WORKSHEET 3 Mission Statement

Worksheet 3 includes a mission statement, and is used to set goals, and includes ideas on how to accomplish them.

**The mission (primary goal) of the Group is protection of the delineated source water area supplying water to the PWS wells at the KBIC Tribal Housing Community on Kawbawgam Road.** The Group should function in a communicative, cooperative, and proactive environment. The group needs to use best management practices, have an effective emergency response plan that Group members know and understand, and maintain ***the Source Water Assessment and Protection Plan as needed to keep the document(s) current.***

We have increased the likelihood of the Group obtaining their mission/primary goal by breaking it down into a series of smaller, more easily achievable goals. This worksheet lists the Group's goals and ideas and the steps needed to accomplish them.

The presence of Lake Kawbawgam within the boundaries of the source water area complicates the SWA&PP somewhat. Access to the lake is possible even though no public access sites are located on the lake. Some water from the Lake Kawbawgam drainage basin, which includes Lake Le Vasseur and two branches of Le Vasseur Creek, is likely to be intercepted by the PWS wells as shown on the figures in the WHPA delineation and SWA (appendixes 2 and 3, respectively). The entire watershed is zoned with multiple designations depending on the common use in an area.

**A table of goals has been developed with at least the following minimum categories, although the list most likely will contain others, as time progresses. Additions to the list will be noted within Worksheet 16.**

Goal	How does group accomplish goal
Keep petroleum products from entering soil in source water area	Educate residents of KBIC Tribal Housing and private citizens of Lake Kawbawgam area on proper disposal techniques and the dangers of on-site disposal.
Keep untreated or poorly-treated human waste from entering Lake Kawbawgam and PWS wells	Inspect KBIC Tribal Housing and gaming facility septic systems to ensure proper operation. Educate private residents of Lake Kawbawgam area on the benefits of maintaining septic systems in proper working order.
Keep hazardous chemicals and other contaminants such as lawn chemicals and petroleum products from entering Lake Kawbawgam	Educate Tribal members and private residents of Lake Kawbawgam area on the benefits of keeping hazardous chemicals and other contaminants from entering Lake Kawbawgam.
Keep hazardous chemicals and other contaminants from entering the basin upstream of Lake Kawbawgam	Work with Chocolay Township to insure that zoning restrictions included in the Township Zoning Ordinance protect the watershed and are adequately enforced

## ***B.2 DELINEATION***

### **WORKSHEET 4 WHPA Delineation**

The worksheet consists of information needed for delineation. A WHPA delineation and SWA were completed as part of the USGS water-resources investigation (appendixes 2 and 3, respectively).

### **WORKSHEET 5 Drinking Water Source Location**

#### **Drinking Water Source**

Location: Kawbawgam Road Tribal Housing Community; Marquette County

Mailing Address: Keweenaw Bay Indian Community Housing Authority, 107 Beartown Road, Baraga, Michigan, 49946

Organization: Keweenaw Bay Indian Community

Name of source: Jacobsville Sandstone

Location of wells: N46° 28' 49" W87° 14'36"

Physical description of wells: The Tribal Housing, Community wells, PWS1 and PWS 2, were drilled in 1990 and 1991, respectively. PWS1 has a 6-inch diameter steel casing and is completed to a depth of 145 feet (ft) and PWS2 has an 8-inch steel casing and is completed to a depth of 138 ft. PWS1 is open to 20.5 ft aquifer material (Jacobsville sandstone) and PWS2 is open to 15 ft of aquifer material. Both wells are equipped with 100 gallon-per-minute (gpm) submersible pumps, but were set to pump at 50 to 53 gpm in 1999 (Carl Rasanen, KBIC, oral commun., 1999), and feed a common treatment area. Only one well is typically used at a time and the other well is kept on standby to satisfy firm capacity requirements and allow for maintenance. However, both wells can pump simultaneously as needed to meet demand, which is notably higher in hot, dry summer months.

## ***B.2 WHPA DELINEATION***

The WHPA delineation (appendix 2) includes a detailed description of the source water area contributing to the PWS and gaming facility wells as well as the methods chosen to delineate the source water area, with a thorough discussion of surficial as well as subsurface flow to the PWS and gaming facility wells.

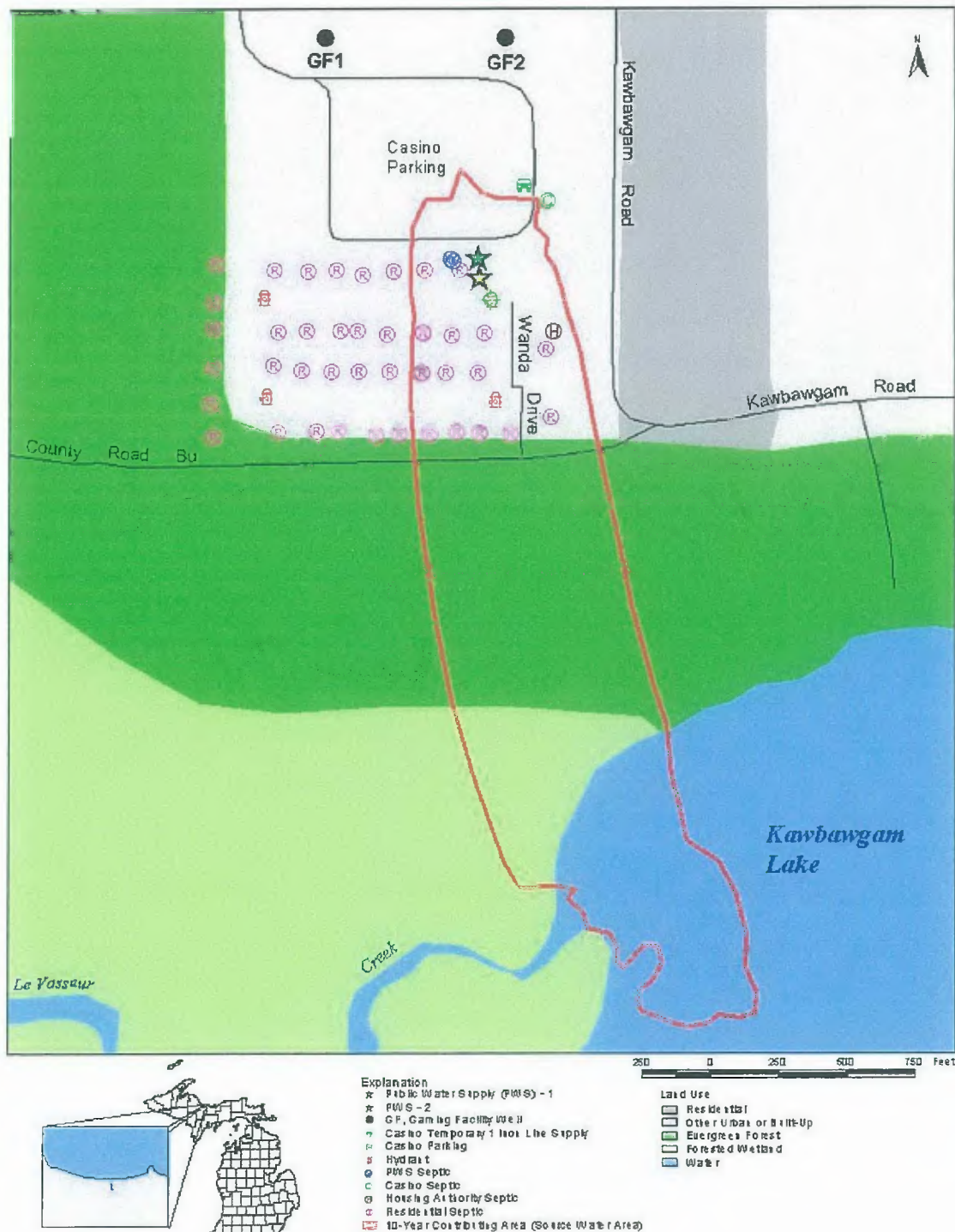
### **Ground-water flow model prepared for WHPA delineation**

USGS investigated a number of different options prior to selecting a MODFLOW (McDonald and Harbaugh, 1988, 1996) ground-water model to complete the WHPA delineation for the Kawbawgam Road PWS wells. USGS chose MODFLOW, which is a three-dimensional finite-difference modeling program to construct the model for the Kawbawgam Road PWS wells after reviewing the information available. A properly constructed MODFLOW model typically provides a more accurate representation of aquifer conditions than less-complex models, where multiple aquifers and confining layers are present. A complete discussion of the methods chosen and modeling results is

included in the WHPA Delineation (appendix 2). The proceeding figure shows the source water area and was adapted from the WHPA Delineation (appendix 2).

The completed SWA&PP and Contingency Plan should enable the Kawbawgam PWS operators and KBIC Environmental Staff to react rapidly to problems within the delineated watershed area. Should a contaminant spill or some other problem impacting the ability of the PWS wells to produce potable water occur, the MODPATH model could be re-run with various time scenarios less than 10 years in duration to assist KBIC environmental and housing staff with contingency planning, including water supply augmentation or even replacement, if necessary.

The proceeding figure from the SWA (p. 3, appendix 3) graphically illustrates potential contaminant sources within the source water area of the Kawbawgam PWS wells. The delineated source water area is shown, with symbols and codes for a number of different layers including 10-year contributing area, PWS well locations, potential contaminant sources (PCS) including septic locations, land-use, and streams, lakes, and drains.



### *B.3 CONTAMINANT INVENTORY*

#### **WORKSHEET 9 RECORDS REVIEW FOR CONTAMINANT INVENTORY**

Past, current, and potential future sources of contaminants were inventoried to identify several categories of potential sources of contaminants including microorganisms (bacteria, oocysts, and viruses), inorganic compounds (nitrates and metals), organic compounds (solvents, petroleum compounds, pesticides), and disinfection by-product precursors (trihalomethanes, haloacetic acids).

It is important to remember that sites and areas identified by this process are only **potential contaminant sources** (PCS) to the drinking water. Environmental contamination is not likely to occur when potential contaminants are used and managed properly. In addition, assumptions were made about particular types of land uses and risks associated with those land uses, and these are discussed further in the results portion of this report.

The purpose of the inventory is three fold: 1) provide information on the location of PCS, especially those within the susceptible area; 2) to provide an effective means of educating the public about PCS; 3) to provide a reliable basis for developing a management plan to reduce potential contaminant risks to the source water area of the Kawbawgam Road PWS wells.

The inventory process attempts to identify potential point-source contaminants within the SWA&PP. It does not include an attempt to identify specific potential contamination problems at specific sites, such as facilities that do not safely store potentially hazardous materials. However, assumptions were made about particular types of land use. For example, it is assumed that rural residences associated with farming operations have specific potential contamination sources such as fuel storage, chemical storage and mixing areas, and machinery repair shops. It should also be noted that although the inventory depicts existing land uses, these are likely to undergo continual change due to normal crop rotation practices. What is irrigated farmland now may be a non-irrigated tree farm, or vice versa.

The results of the inventory were analyzed in terms of current, past, and future land uses and their relation to the susceptible area and the wells. In general, land uses and PCS that are closest to the delineated source water area pose the greatest threat to a safe drinking water supply. Inventory results are summarized in table below.

### Potential contaminant sources in the Kawbawgam Road wellhead protection area

Type of potential contaminant source	Number of potential contaminant sources in the Source Water Area	Number of potential contaminant sources in the susceptible area
Hazardous or Solid Waste Site	0	0
Industrial Facilities Discharge Site	0	0
National Priority List Sites	0	0
Permit Compliance System	0	0
Toxic Release Inventory	0	0

The **known potential** sources of contamination within the delineated source water area are septic systems for 14 single-family homes within the housing community, the housing office, and the commercial septic system for the gaming facility (p. 7, appendix 3); and the parking lot, generator, trash compacting dumpster, and materials storage area behind for the gaming facility; and infiltration gallery for filter backwash from the PWS well house, which is currently inoperative. The Tribe should take steps to ensure that proper and timely maintenance of septic system is continued.

The ground-water flow model used to produce the WHPA delineation shows that water from Lake Kawbawgam may enter the public water supply system at the southern end of the zone of contribution. Because of this, the entire upstream drainage basin, much of which is either sparsely inhabited should be considered a source area for contamination. Hazardous material could enter the surface water system throughout the basin and move into Lake Kawbawgam. It is possible that the geologic materials comprising the bottom of the lake could prevent contaminants from reaching the PWS wells, but no information is currently known to assist with that determination.

### WORKSHEET 10 WINDSHIELD SURVEY

A windshield survey was completed during August 2003 of all easily accessible areas within the source water area. Results of the windshield survey are included in tables included in Worksheet 14. As noted in the preceding section, **known potential** sources of contamination within the delineated source water area noted during the windshield survey are the septic systems for 14 single-family homes within the housing community, the housing office, and the commercial septic system for the gaming facility (p. 7, appendix 3); and the parking lot, generator, trash compacting dumpster, and materials storage area behind for the gaming facility; and infiltration gallery for filter backwash from the PWS well house, which is currently inoperative. In addition, non-Tribal residences on both south and north shore are built adjacent to Lake Kawbawgam and several public stream crossings also cross tributaries to the lake basin.

## WORKSHEET 12 ABANDONED WELL SURVEY

This worksheet is intended to document the location of abandoned ground-water wells within, or near, the source water area of the Kawbawgam Road PWS wells. It is possible that there are unused wells located at one or more of the houses along Kawbawgam Road. However, the source water area does not include any of the Kawbawgam road residences and only a single well completed in the Jacobsville Sandstone aquifer is known to have been drilled at a Kawbawgam Road residence, about a mile east of the PWS wells. That well was not located during the USGS study in 1999 and may have been abandoned.

Additionally, both of the households located on the south shore of the lake that granted access to their wells completed in the Jacobsville Sandstone aquifer during the WHPA delineation have (3) unused wells, total. The wells are outside the 10 yr. contributing area (figure 2, appendix 2). The three, unused wells are listed in the short table below. The current owners of the wells have properly maintained the wells and they are not considered a serious threat to the source water area. It is possible that owners of the wells could be enticed into abandoning their unused wells by providing funding to complete the task.

Obviously, the cost of abandoning all of the abandoned wells within the source water area is less than replacing the current water system.

The Group will initially consider an informational approach to this issue.

Potential contaminant source/abandoned well	Location/address	Depth of abandoned well	Documentation of well abandonment filed with MDEQ, County, etc.
Abandoned well-RWGE	1002 Mangum Rd., Marquette, MI	120 ft.	None
Abandoned well-RWCK1	Unknown /south shore of Lk. Kawbawgam	Unknown	Unknown
Abandoned well-RWCK2	Unknown /south shore of Lk. Kawbawgam	Unknown	Unknown

### WORKSHEET 13 P.C.I.: Naturally Occurring Sources

The process for completing the Potential Contaminant Inventory included several steps, which are summarized in appendix 5.

The contaminant inventory checklist should be kept updated by the Group as information is collected. It is likely that only a few of the categories will apply to the Kawbawgam Road PWS wells source water area, but the information gained may be important for the protection strategy of the source water area. Zoning and other local changes could be made to protect the source water area if the Group is made aware that a threat to the water source exists that was not even considered prior to completion of this list.

#### CONTAMINANT INVENTORY CHECKLIST

Check if present	Naturally occurring sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
Yes	Rocks and soils	e.g., metals, iron, arsenic, magnesium, sulfates, fluorides, etc.	Iron in unconsolidated deposits and Jacobsville Sandstone aquifer	Entire source water area
Yes	Decaying organic matter	e.g., bacteria		Wetlands adjacent to Lakes LeVasseur and Kawbawgam
Possible	Radioactive materials	e.g., radon gas, Uranium	Present in unconsolidated deposits and Jacobsville Sandstone aquifer elsewhere in U.P.	Entire source water area
Possible	Natural geological processes	e.g., salt water infiltration of wells	Present in Jacobsville Sandstone aquifer elsewhere in U.P.	Entire source water area

### WORKSHEET 13 Agricultural and Logging Sources

Check if present	Agricultural and logging sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None Noted	Crop areas, irrigation sites	e.g., pesticides, petroleum products		
None Noted	Chemical storage	e.g., pesticides, herbicides, fertilizers, petroleum products, solvents, paints, etc.		
None Noted	Farm/logging machinery	e.g., fuel, lubricants, hydraulic oil, solvents		
Yes	Stream crossings	e.g., sedimentation, petroleum products, etc.	Each road crossing of Kawbawgam and Magnum Roads	At least 1 mile, varies

# WORKSHEET 13 Residential Sources

## CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Residential sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
Yes	Abandoned wells	e.g., petroleum products, etc.	Abandoned or unused wells on residential sites within the 10 yr. SWA	Varied
Yes	Artificial ground-water recharge	e.g., storm water runoff, treated sewage effluent that may contain detergents, solvents, etc.	Every residential site within the 10 yr SWA is a potential source, i.e., each septic.	Varied
Yes	Household chemicals	e.g., cleaners, bleach, paint and paint removers, strippers, petroleum products	Every residential site within the 10 yr SWA is a potential source	Varied
Yes	Lawn and gardens	e.g., pesticides and herbicides, petroleum products	Every residential site within the 10 yr source water area is a potential source	Varied
None Noted	Swimming pools	chemicals		
Yes	Septic systems and sewage lines	e.g., sewage, bacteria, viruses, metals, petroleum products, anti-freeze, road salt, chemicals, etc.	Every residential site within the 10 yr SWA is a potential source	Varied
Possible	Underground and above ground storage tanks	home heating oil		May be present at homes outside of source water area

## WORKSHEET 13 Municipal Sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Municipal sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None noted	Parks	e.g., pesticides, herbicides, petroleum products		
Yes	Highways, roads	e.g., herbicides, road salt, petroleum products, etc.	All roads and parking locations within the source water area	Several locations
None noted	Municipal sewage	e.g., sewage, sludge, treatment by-products, chemicals, bacteria, viruses		
None noted	Storage, treatment, and disposal ponds and other surface impoundments	e.g., sewage, wastewater, liquid chemical wastes, bacteria, viruses		
None noted	Sewer overflows	e.g., road runoff, bacteria, viruses		
None noted	Recycling facilities	e.g., petroleum products, battery acid, anti-freeze, metals, etc.		
None noted	Landfills	e.g., chemicals, petroleum products, solvents, etc.		
None noted	Illegal dumps and open burning areas	e.g., chemicals, metals, petroleum products, metals, solvents, etc.		
None noted	Municipal incinerators, burning areas	e.g., metals, chemicals, sulfur, etc.		
None noted	Water supply wells	e.g., surface runoff, chemicals, etc.		
None noted	Drainage wells	e.g., pesticides, herbicides, bacteria, etc.		
Yes	Sumps and dry wells	e.g., storm run-off water, spilled liquids, dumped liquids, minerals, etc.	Filter backwash from PWS well house, infiltration galleries not functioning correctly Aug. 2003	100 to 300 ft

## WORKSHEET 13 Commercial Sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Commercial sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None noted	Airports and airfields	e.g., fuels, solvents, de-icers, wastes		
None noted	Auto repair shops	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.		
None noted	Barber and beauty shops	e.g., perm solutions, dyes, chemicals, etc.		
None noted	Boat yards and marinas	e.g., fuels, lubricants, solvents, paints, wood preservatives, waxes, etc.		
None noted	Bowling alleys	e.g., epoxy floor finishes, solvent, cleaning fluids		
None noted	Automobile dealerships	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.		
None noted	Car washes	e.g., soaps, detergents, petroleum products, anti-freeze, acids, road salt, etc.		
None noted	Campgrounds	e.g., sewage, petroleum products, pesticides, household wastes		
None noted	Carpet stores	e.g., glues and solvents, petroleum products		
None noted	Cemeteries	e.g., chemicals, petroleum products, herbicides, etc.		
None noted	Construction areas	e.g., solvents, asbestos, paints, glues, insulation, tars, sealants, chemicals, etc.		
None noted	Dry cleaners	e.g., solvents, chemicals, etc.		
None noted	Furniture refinishers	e.g., paints, stains, solvents		

CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Commercial sources-continued	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None noted	Gasoline dealers	e.g., petroleum products		
None noted	Hardware and lumber stores	e.g., chemicals, stains, paints, petroleum products, etc.		
None noted	Heating oil suppliers	e.g., petroleum products including stored materials		
None noted	Horticultural practices	e.g., herbicides, pesticides, fungicides		
None noted	Jewelry/metal plating	e.g., sodium and hydrogen cyanide, metallic salts, acids, chromium, etc.		
None noted	Laundromats	e.g., detergents, bleaches, dyes		
None noted	Medical institutions	e.g., X-ray developers/fixers, infectious wastes, disinfectants, radioactive wastes, pharmaceuticals, etc.		
Yes	Office buildings	e.g., building wastes, lawn and garden maintenance chemicals, etc.	Gaming facility generator, septic system, parking lot, trash compactor, and maintenance area	50 to 800 ft
None noted	Paint stores	e.g., paints, stains, solvents, wood preservatives, etc.		
None noted	Pharmacies	e.g., spilled and returned products		
None noted	Photography shops and labs	e.g., silver sludges		
None noted	Print shops	e.g., inks, solvents, photo chemicals		
Yes	Railroads	e.g., herbicides, petroleum products, chemicals, etc.	Abandoned RR grade north of gaming facility parking lot	~2,000 ft
None noted	Research laboratories	e.g., X-ray fixers/developers, infectious/radioactive wastes, disinfectants, pharmaceuticals		

CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Commercial sources-continued	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
Yes	Scrap and junk yards	e.g., wastes such as metals, chemicals, petroleum products, solvents, acids, anti-freeze, etc.	Junkyard in backyard along Kawbawgam Road	~2,500 ft east of source water area
None noted, but possible	Storage tanks	e.g., any chemical in a storage tank		
Yes	Transportation services	e.g., petroleum products, solvents, etc.	Fuel tanks in Casino Shuttle buses and diesel fuel tank on ground at housing office	100 to 300 ft
None noted	Veterinary services	e.g., solvents, infectious wastes, vaccines, disinfectants		

## WORKSHEET 13 Industrial Sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Industrial sources	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None noted	Material stockpiles (coal, metallic ores)	e.g., acid drainage, metals runoff		
None noted	Waste tailing ponds/basins	e.g., acids, metals, radioactive ores		
None noted	Transport and transfer stations	e.g., fuel tanks, repair shop wastes, etc.		
None noted	Storage tanks (above and below ground)	e.g., petroleum products		
None noted	Storage, treatment, or disposal ponds & other surface impoundments	e.g., sewage wastewater, liquid chemical wastes, bacteria, viruses		
None noted	Chemical landfills	e.g., hazardous and no-hazardous liquid wastes		
None noted	Radioactive waste disposal sites	e.g., radioactive wastes from medical facilities, power plants, or defense operations		
None noted	Dry wells	e.g., saline water		
None noted	Injection wells	e.g., oil field brine, chemicals, wastes, etc.		

## WORKSHEET 13 Industrial Processes

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Industrial processes	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
None noted	Asphalt plants	e.g., metals, chemicals, sulfur, etc.		
None noted	Communication equipment manufacturers	e.g., acid wastes, metal sludge's, etchants, cutting oils, plating wastes		
None noted	Electronic equipment manufacturers	e.g., cyanides, solvents, acids, paints, PCBs, etchants		
None noted	Foundries and metal fabricators	e.g., heavy metals, paint wastes, plating wastes, solvents, oils, etc.		
None noted	Furniture and fixtures manufacturers	e.g., paints, stains, solvents, degreasers		
None noted	Metal and metal-working shops	e.g., solvents, lubricants, degreasers, metals		
None noted	Mining operations	e.g., mine spoils, tailings, stamp sands, acids, highly-mineralized water, etc.		
None noted	Unsealed abandoned mines used for waste pits	e.g., metals, acids, minerals, sulfides, etc.		
None noted	Paper mills	e.g., metals, acids, chlorine, etc.		
None noted	Petroleum storage companies	e.g., petroleum products		
None noted	Industrial pipelines	e.g., corrosive fluids, petroleum products, hydrocarbons, etc.		
None noted	Photo processing labs	e.g., silver sludge's, cyanides, chemicals, etc.		
None noted	Plastics materials and synthetics producers	e.g., solvents, oils, cyanides, acids, formaldehyde		
None noted	Publishers, printers, and allied industries	e.g., inks, solvents, dyes, photographic chemicals		

## CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Industrial processes-continued	Potential contaminants	Potential contaminant source(s)	Distance from Kawbawgam Road PWS wells
Possible	Public utilities	e.g., PCB from transformers and capacitors, oils, solvents, metal plating solutions	Transformers on poles may still contain PCB's	Varies, numerous
None noted	Sawmills and planers	e.g., wood residue, treated wood preservatives, paints, glues		
None noted	Stone, clay, and glass manufacturers	e.g., solvents, oils and grease, glazing materials, metal sludge's		
None noted	Welding shops	e.g., oxygen and acetylene, metals		
None noted	Wood preserving facilities	e.g., wood preservative chemicals, creosote		

### ***B.4 SUSCEPTIBILITY DETERMINATION***

The following is a narrative approach to susceptibility, complemented by the EPA Region 5 Susceptibility worksheet, which is attached as appendix 6.

Near the Kawbawgam Road PWS wells, the land is used for commercial purposes (KBIC gaming facility) and residential development. South of the wells and the residential area, the land is classified as wooded and wetland. The most southern part of the area that contributes recharge to the PWS wells is under Lake Kawbawgam. There are several possible sources of contamination within the source water area; point sources include septic systems for the 14 private residences, housing office, and the gaming facility; and trash compactor, maintenance area, and standby generator at the gaming facility. Non-point sources include lawn chemicals, and the parking lot for the gaming facility, because of fuels and other fluids leaking from vehicles. Within the 10-year time of travel (figure 2, appendix 2) to the wells identified by the USGS, there are no regulated facilities, or facilities with permits to store, handle, or discharge potential contaminants. The susceptibility of the source water to contamination is considered low. KBIC owns all land within 200 ft of the wellheads of the PWS system.

#### **Geologic Susceptibility**

The following discussion is largely excerpted from the WHPA delineation (appendix 2). The source of water for the Kawbawgam Road PWS wells is the Jacobsville Sandstone, which is a bedrock aquifer present throughout much of the Upper Peninsula. Near the wells, the Jacobsville Sandstone is primarily overlain by sand, with some areas of silty,

and or, clayey sand. The upper part of the Jacobsville Sandstone is probably more productive than other parts of the formation. The formation is friable, highly fractured, and parts along bedding planes in outcrop, although it known to become more massive at depth. The Kawbawgam Road wells are completed in the upper 26 to 31 feet of the formation, and are much more productive than other wells completed in the formation throughout the Upper Peninsula of Michigan. The Kawbawgam Road wells are capable of producing as much as 100 gallons per minute. Static water levels are about 35 feet below the surface in the area. Because of the relatively high permeability of overlying sands throughout the source-water area, the geological susceptibility of the source water to contamination is considered high.

### **Historical Contaminant Detections**

The Kawbawgam Road PWS well records show that the plant currently produces about 9,600 gallons per day (five-year average). Water quality conditions have been monitored on a routine basis since the wells were installed and became operational. Water quality is good, exceeding USEPA Drinking Water Quality Standards for most constituents except iron.

Annual monitoring for Volatile Organic Contaminants (VOCs) occurred in years 1993, 1995, 1996 and 1999. In 1998, the US EPA, Region 5 Safe Drinking Water Branch, placed Kawbawgam Road PWS well on a three-year monitoring schedule (Mary Morgan, written comm., 1998). The next sampling is to occur for the 2002-2004 Compliance Period. Historical (VOC) detections are listed below.

In 1996, detections above the Method Detection Limit (MDL), but below the Maximum Contaminant Level (MCL) occurred for the following analytes; Bromoform, Chlorodibromomethane, Chloroform, Dichlorobromomethane, Total Trihalomethanes, Xylene Meta- & Para- and Xylenes Total.

In 1997, detections above the Method Detection Limit (MDL), but below the (MCL) occurred for the following analytes; Bromoform, Chlorodibromomethane, Chloroform, Dichlorobromomethane, Total Trihalomethanes, Ortho-Xylene, Meta-&Para-Xylene, and Total Xylenes.

Trace detection above the (MDL) but too low to quantitate was recorded for the analyte Ethylbenzene.

In 1999, detections above the Method Detection Limit (MDL), but below the (MCL) occurred for the following analytes; Chlorodibromomethane, Chloroform, Dichlorobromomethane and Total Trihalomethanes.

## **C.1 STRATEGIES FOR PROTECTING DRINKING WATER SOURCES**

- A) Non-regulatory strategies
- B) Regulatory strategies
- C) Planning for the future
- D) Contingency planning

### **Building a Source Water Assessment Protection Program**

Once a SWA&PP is completed, the focus shifts to protection. New information should be added as it becomes available, as the SWA&PP becomes a “living” document. The SWA&PP uses information collected during the assessment phase to develop community-based strategies for long-term protection of the source water. Public notification and participation play pivotal roles in the process, giving the public input into the process. Protection strategies do not have to represent large departures from current Tribal laws, policies, and restrictions, and could simply require enforcement of current laws, codes, and ordinances. The biggest complication with the source water area for the Kawbawgam Road PWS wells is that it extends past Tribal, but KBIC has a good relationship with private citizens around the source water area. The SWA&PP Group plays a key role in the entire process, weighing the advantages and limitations of various management strategies, and assessing their ultimate value to the SWA&PP.

### **Non-regulatory Strategies**

Non-regulatory strategies are considered the least-costly, but possibly less effective method of choice for KBIC, given the limited amount of resources available. The following are just a few examples of the strategies KBIC has used in the past and/or plans to use in the future.

A continuing public education program for tribal residents within the (WHPA), as well as non-tribal residents near the (WHPA). This includes dissemination of the (SWA) to inform the public and also programs, flyers and signs that encourage voluntary protection and conservation.

Water conservation is already practiced at the (PWS). The pumps only operate at an estimated minimum rate, one at a time, which can be increased to both pumps simultaneously, as demand increases in the hot, dry summer months.

Marquette County already sponsors a residential hazardous waste disposal program. KBIC plans to re-inform the residents in and around the (WHPA), of the program and it's contact information.

### **Regulatory Strategies**

KBIC has a limited range of regulatory strategies that are available due, in part to the limited amount of tribal-owned land within the (WHPA). Health based regulations were followed for the location, construction and operation of the septic systems within the (WHPA), for the existing residential septic systems as well as for the Casino and

Community Building septic systems. Size and location of these systems can be inferred from the IHS sanitation diagram (Appendix 7).

In the future, KBIC may consider codes or ordinances that restrict or regulate the use and/or storage of hazardous chemicals or materials. Other strategies such as land-use regulations or codes, buffer zones or setbacks, aren't applicable as the tribal-owned land has already been developed within the (WHPA).

### **Planning for the Future**

A representative of the Group could visit each house within the source water area with an informational package. The informational package should, at a minimum, include a map of the source water area, information about properly and improperly abandoned wells, a list of local contractors that do the work, and an estimate of typical cost of the procedure. A brief interview of the property owner at this time could also provide information for the Resident Survey.

A formal, public education program designed by the Management Group may be put into effect, in the future.

The Management Group shall also perform a yearly review of this document to insure it is up to date.

### **Contingency plan**

Even though the source water area of the Kawbawgam Road wells is relatively removed from population centers and many sources of contamination typical of larger municipal water systems, the drainage basin contributing to Lake Kawbawgam is relatively large and contains at least a public access site on Lake Le Vasseur and several road crossings. A contingency plan was prepared as a separate document to accompany the SWA&P (appendix 4). The contingency plan has identified a strategy KBIC will follow for supplying an emergency short-term supply of potable water should the Kawbawgam Road PWS wells be rendered unusable by either accidental or malicious contamination and considers longer-term alternatives to the Kawbawgam Road wells should the system be rendered unusable for longer periods of time.

### **WORKSHEET 15 EVALUATION OF MANAGEMENT STRATEGIES**

The following worksheet should be used to help evaluate the worth of various strategies for minimizing or preventing contamination of drinking water sources.

<b>Option</b>	<b>Advantages</b>	<b>Limitations</b>	<b>Resources needed</b>
Public Education	Inexpensive, simple to implement	Relies on voluntary public response	Brochures, fliers, signs, posters,
Water conservation	Free, little effort required	Relies on voluntary public response	Public education, or a volume-based rate structure.
Kawbawgam Lake water monitoring	Ten yr. advance notice of potential water quality issues.	Funding, staff	Funding, staff, training, access and equipment

Regulation of use/storage of hazardous materials	Addresses possible contaminants, directly. Increases overall safety of the area.	Requires training of staff. Requires monitoring to insure compliance. Relies on current regulations, further regulation could be costly and time-consuming	Enforcement, monitoring, training, equipment, possibly containment facilities.
Land use regulations	Control over more of the (SWA)	Can only regulate tribal land. Majority of the tribal land within the (SWA) is already developed for residential use.	Time and funds to adopt new regulations. Area studies.
Land purchase	Greater control over the (SWA)	Costly. Availability of land for purchase.	Funding and available land.
Spill response plans for most significant (PCS's)	Greater control and better response to spills/contamination. Can also be incorporated into the (PWS) contingency plan in the future.	Enforcement requires compliance	Time, staff, funding, training and equipment

## WORKSHEET 16 SOURCE WATER PROTECTION PROGRAM CHECKUP

Used to update information and include listing of new, or previously unlisted, delineations, and facilities in the protected area. Additionally, try to incorporate any changes within the source water area that might increase the potential for contamination, contingency plans, or strategies used to maintain or expand the SWA&PP. Some example questions are included below.

- 1) List any new facilities in, or near, the source water area since the last update.
- 2) List any changes in existing sites that may increase the potential to contaminate the Kawbawgam Road PWS wells.
- 3) Describe changes made to, maintenance performed on, wells, structures, piping, treatment plant, etc. to the Kawbawgam Road PWS wells.
- 4) Were contingency plans implemented at any time since last update? If so, what changes, if any, are needed in the contingency plans?
- 5) Were any new management strategies introduced since previous update? If so, describe the strategies and the reason for their adoption.
- 6) Add those strategies to worksheet 15 and complete their evaluation.
- 7) Describe any environmental changes that have affected the source water area and the surrounding land such as forest fires, flooding, etc.

### Selected References

- Grannemann, N.G., 1984, Hydrogeology and effects of tailings basins on the hydrology of Sands Plains, Marquette County, Michigan, U.S. Geological Survey, Water-Resources Investigations Report 84-4114, 98 p.
- McDonald, M.G., and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 6, Chap. A1, 576 p.
- McDonald, M.G., and Harbaugh, A.W., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.
- Michigan Department of Environmental Quality, 1999, State of Michigan source water assessment program, 153 p.
- Michigan Section, American Water Works Association and Michigan water Environment Association, 2001, Source water protection, a joint position statement, 2 p.
- MIRIS, 2000, Michigan Resource Information System: Michigan Department of Natural Resources, Land and Water Management Division, 2 compact discs, as updated.
- Pollock, D.W., 1989, Documentation of computer programs to compute and display pathlines using three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 89-381, 188 p.
- Sweat, M.J., 2002, Source water assessment report for the Kawbawgam Road water supply, Michigan Source Water Assessment Report 72: U.S. Geological Survey – WRD, 8 p.

- Totten, Glenn, 2000, Protecting drinking water: a workbook for Tribes: Water education Foundation, *and modified by U.S. EPA Region 5*, 108 p.
- U.S. Environmental Protection Agency, 1998, Better assessment science integrating point and non-point sources: BASINS Version 2.0 EPA 823-B-98-006, variably numbered.
- U.S. Environmental Protection Agency, 2000, Assessment protocol for Great Lakes Sources: final draft (revised 6/6/00) by Great Lakes Protocol Workshop, 6 p.
- Weaver, T.L., Luukkonen, C.L., and Ellis, J.M., 2000, Simulation of ground-water flow and delineation of contributing area to public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigation Report, 00-4050, 25 p.

## Appendix 1

### MSAWWA and MWEA Joint Position Statement

The Michigan Section of the American Water Works Association (MSAWWA) and the Michigan Water Environment Association (MWEA) issued a joint position statement in September 2001 detailing their interpretation of SWP. The following introduction is largely excerpted from their position statement. Both associations are dedicated to protecting Michigan's waters with members supporting public involvement through awareness, willingness to support clean water activities, and promoting public health and public confidence in drinking water supplies. Source water protection is one of many barriers or safeguards available to a water supplier to protect public health, such as proper intake/well construction and maintenance, water treatment, operator training, and a host of other activities. The position of MSAWWA and MWEA is that wellhead protection (WHP) and SWP are synonymous for ground-water supplies.

- Defining roles and duties of government units and water supply agencies.
- Delineating a source water protection area for each water supply source, based on the state's defined source water area.
- Identifying potential contaminant sources within each source water protection area.
- Utilizing management approaches for protection of source water, including but not limited to education and regulatory approaches.
- Creating contingency plans for public water supply sources including the location of alternate drinking water supplies.
- Assuring proper siting of new water sources to minimize potential contamination.
- Encouraging public participation.

The elements listed above have been applied successfully in WHP programs, and translate directly to SWP. The associations believe that a program of this kind is necessary for protection of local drinking water sources. They do not believe that local efforts by themselves are likely to be sufficient. At the local level, SWP is instituted through WHP programs and watershed management plans plus efforts such as hazardous material training, zoning, local ordinances, abandoned well management, illegal connection programs, storm water treatment, street and catch basin cleaning plus public education.

***It is important that state, local and Tribal authorities work together to accurately assess source water susceptibility.*** Since assessment criteria involve dynamic, changing parameters, source water assessments should be periodically updated to prioritize additional SWP activities.

## **Appendix 2**

U.S. Geological Survey Water Resources Investigation Report 00-4050, Simulation of ground-water flow and delineation of contributing area to public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan.

# Simulation of Ground-Water Flow and Delineation of Contributing Area to Public Water Supply Wells, Keweenaw Bay Indian Community, Marquette County, Michigan

---

Department of the Interior  
U.S. Geological Survey

*Water-Resources Investigations Report 00-4050*

Prepared in cooperation with the Keweenaw Bay Indian Community



# Simulation of Ground-Water Flow and Delineation of Contributing Area to Public Water Supply Wells, Keweenaw Bay Indian Community, Marquette County, Michigan

---

*By* T.L. Weaver, C.L. Luukkonen, and J.M. Ellis

Lansing, Michigan  
2000



U.S. DEPARTMENT OF THE INTERIOR  
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY  
Charles G. Groat, Director

---

For additional information write to:

District Chief  
U.S. Geological Survey, WRD  
6520 Mercantile Way, Suite 5  
Lansing, Michigan 48911

Copies of the report can be purchased  
from

U.S. Geological Survey  
Branch of Information Services  
Box 25286  
Denver, CO 80225-0286

## CONTENTS

## Page

Abstract	1
Introduction	1
Physical Setting	2
Methods of Investigation	5
Hydrogeology	5
Lithology	5
Aquifer Test and Analysis	6
Water Quality	9
Description of Wells	10
Community Water Supply System	10
Residential Wells	10
Simulation of Ground-water Flow	11
Conceptual Model	11
Numerical Model	11
Model Grid and Layers	12
Boundary Conditions	12
Hydraulic Properties	16
Model Calibration	17
Delineation of Contributing Area	19
Model Limitations	21
Summary	24
References Cited	24
Appendix A: Driller's logs of domestic supply wells completed in the Jacobsville Sandstone Formation	A-1
Appendix B: Driller's logs of domestic supply wells completed in glacial and lacustrine deposits	B-1
Appendix C: Driller's logs of Keweenaw Bay Indian Community wells	C-1
Appendix D: Results of aquifer test conducted on Keweenaw Bay Indian Community public water supply wells in 1991	D-1

## FIGURES

## Page

1. Location of the Keweenaw Bay Indian Community, near Marquette, Michigan	3
2. Modeled area plotted on USGS 1:24,000 quadrangle map showing 10-year contributing areas for public water supply wells and gaming facility wells, Keweenaw Bay Indian Community study area	4
3. Generalized hydrogeologic section A-A <sup>3</sup> showing potentiometric surface and stratigraphic relations of Jacobsville Sandstone Formation and younger geologic units, Kawbawgam Lake area, Marquette County, Michigan	7
4. Generalized hydrogeologic section A <sup>4</sup> -A <sup>1</sup> showing potentiometric surface and stratigraphic relations of Jacobsville Sandstone Formation and younger geologic units, Kawbawgam Lake area	7
5. Generalized hydrogeologic section A-A <sup>2</sup> showing potentiometric surface and stratigraphic relations of Jacobsville Sandstone Formation and younger geologic units, Kawbawgam Lake area	7
6. Analysis of aquifer test of public water supply wells, Keweenaw Bay Indian Community	
a. Using the methods of Theis for confined aquifers	8
b. Using the methods of Neuman for unconfined aquifers	8
c. Using the methods of Hantush and Jacob for leaky-confined aquifers	8
7. Modeled area showing MODFLOW grid, cell types, and boundaries, Keweenaw Bay Indian Community study area	13
8. Schematic view of typical model cell, Keweenaw Bay Indian Community study area	14
9. Modeled area showing potentiometric surface without effects of public water supply or gaming facility wells, Keweenaw Bay Indian Community study area	15
10. Modeled area showing dry cells in Layer 1, Keweenaw Bay Indian Community study area	20
11. North-south section view of contributing area to Keweenaw Bay Indian Community public water supply wells	22
12. North-south section view of contributing area to Keweenaw Bay Indian Community gaming facility well	23

## TABLES

1. Results of aquifer test analysis for Keweenaw Bay Indian Community Public water supply wells, Marquette County, Michigan	6
2. Hydraulic parameters used for MODFLOW simulation of ground-water flow. Keweenaw Bay Indian Community	16
3. Results of MODFLOW simulation of groundwater flow. Keweenaw Bay Indian Community	18

## CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot (ft)	30.48	centimeter
mile (mi)	1.609	kilometer
square mile (mi <sup>2</sup> )	2.590	square kilometer
acre	0.405	hectare

**VERTICAL DATUM:** In this report "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in this report: Chemical concentration is given as milligrams per liter (mg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Other abbreviations used in this report are: square miles (mi<sup>2</sup>), feet (ft), feet per day (ft/day), feet squared per day (ft<sup>2</sup>/day), gallons per minutes (gpm), inches per year (in/yr).

# **Simulation of Ground-Water Flow and Delineation of Contributing Area to Public Water Supply Wells, Keweenaw Bay Indian Community, Marquette County, Michigan**

**By T.L. Weaver, C.L. Luukkonen, and J.M. Ellis**

## **ABSTRACT**

The Keweenaw Bay Indian Community (KBIC) in Marquette County, Michigan has two public water supply (PWS) wells completed in the Jacobsville Sandstone Formation. The production capacity of these wells exceeds that of most other wells completed in the formation throughout the Upper Peninsula of Michigan. In 1998, the KBIC was awarded a grant to develop a wellhead protection plan for the PWS wells. As part of that plan, the 10-year contributing areas for the PWS wells and a well at a community-owned gaming facility were delineated.

Geologic, hydrologic, and hydraulic characteristics of the Jacobsville Sandstone and the overlying, hydraulically connected glacial and lacustrine deposits were compiled and used to develop a ground-water flow model of the area based on the U.S. Geological Survey's MODFLOW-96 program. Results of simulations made with MODFLOW were then used in conjunction with the particle-tracking program MODPATH to delineate the contributing areas to the two PWS wells and the gaming facility well. The combined 10-year contributing areas encompass about 0.2 square miles. The zone of contribution (subsurface area through which water moves toward a well) for the PWS wells extends from within the Jacobsville Sandstone upward into glacial and lacustrine deposits, reaching land surface about 1,200 ft south of the wells and extending into Lake Kawbawgam. The zone of contribution for the gaming facility well is entirely within

glacial and lacustrine deposits, intersecting land surface at the well head and extending about 3,300 ft south.

## **INTRODUCTION**

Keweenaw Bay Indian Community (KBIC) in Marquette County, Michigan has two public water supply wells completed in the Jacobsville Sandstone Formation. The wells can pump more water than other known wells completed in the formation throughout the Upper Peninsula of Michigan, where most wells completed in the formation are poor water producers.

In 1998, KBIC was awarded a Source Water Protection grant from the U.S. Environmental Protection Agency (USEPA) to complete a wellhead protection plan (WHPP) for the PWS wells located on tribal lands in Chocolay Township. As part of the WHPP, USGS delineated the 10-year contributing areas for the public water supply wells. A contributing area or wellhead protection area, as defined by USEPA, is the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield (Environmental Protection Agency, 1993). KBIC completed a contaminant source inventory as specified by USEPA guidelines using the contributing area delineated by USGS. Potential sources of contamination are identified within the contributing area by recording existing data, describing sources of contamination within the contributing area, targeting likely sources for further investigation, collecting and interpreting new information on existing or potential sources through surveys, and verifying accuracy and reliability of the information gathered.

The purposes of this report are to describe the hydrogeology of the study area and to delineate the 10-year contributing area to KBIC public water supply wells. The geology and hydrology of the area were described on the basis of analysis of existing

and newly collected data. The new data were collected in spring, 1999.

### Physical Setting

The study area is in Chocolay Township, Marquette County, in the Upper Peninsula of Michigan (fig. 1). KBIC Tribal lands comprise 98 acres of the study area described in this report. The study area (fig. 2), which extends beyond Tribal boundaries for purposes of establishing boundary conditions for the ground-water flow model, comprises about 8.5 mi<sup>2</sup>.

The study area is part of the Chocolay River drainage basin, which flows into Lake Superior several miles west of the study area and several miles east of the City of Marquette. Le Vasseur Creek, Dorow Creek, and Lakes Kawbawgam, Le Vasseur, and Superior are the principal surface-water bodies in the study area, although several unnamed streams and drainage ditches are also present.

Land-surface altitudes range from 601 ft at the shore of Lake Superior to about 700 ft at the southern end of the study area. Most of the northern part of the study area consists of fairly flat-lying beach ridges that are remnants of declining lake levels and isostatic rebound following the Marquette Re-advance of continental glaciation about 10,000 to 9,800 years before present (Farrand and Drexler, 1985). Altitude of the beach ridges is typically less than 650 ft. Relief rapidly changes with the morainal features attaining an altitude of over 1,000 ft several miles south of the southern boundary of the study area. The moraines in this region mark the southern position of the Marquette Re-advance, which probably "stalled" after contacting bedrock highlands. Erosion of clay-rich till directly overlying the Jacobsville Sandstone was probably widespread during the recessionary period following the Marquette Re-advance as glacial meltwater flowed eastward toward glacial Lake Minong (Farrand and Drexler, 1985). Drainage along the ice front was probably extensive for a number of years, resulting in variations in thickness and areal

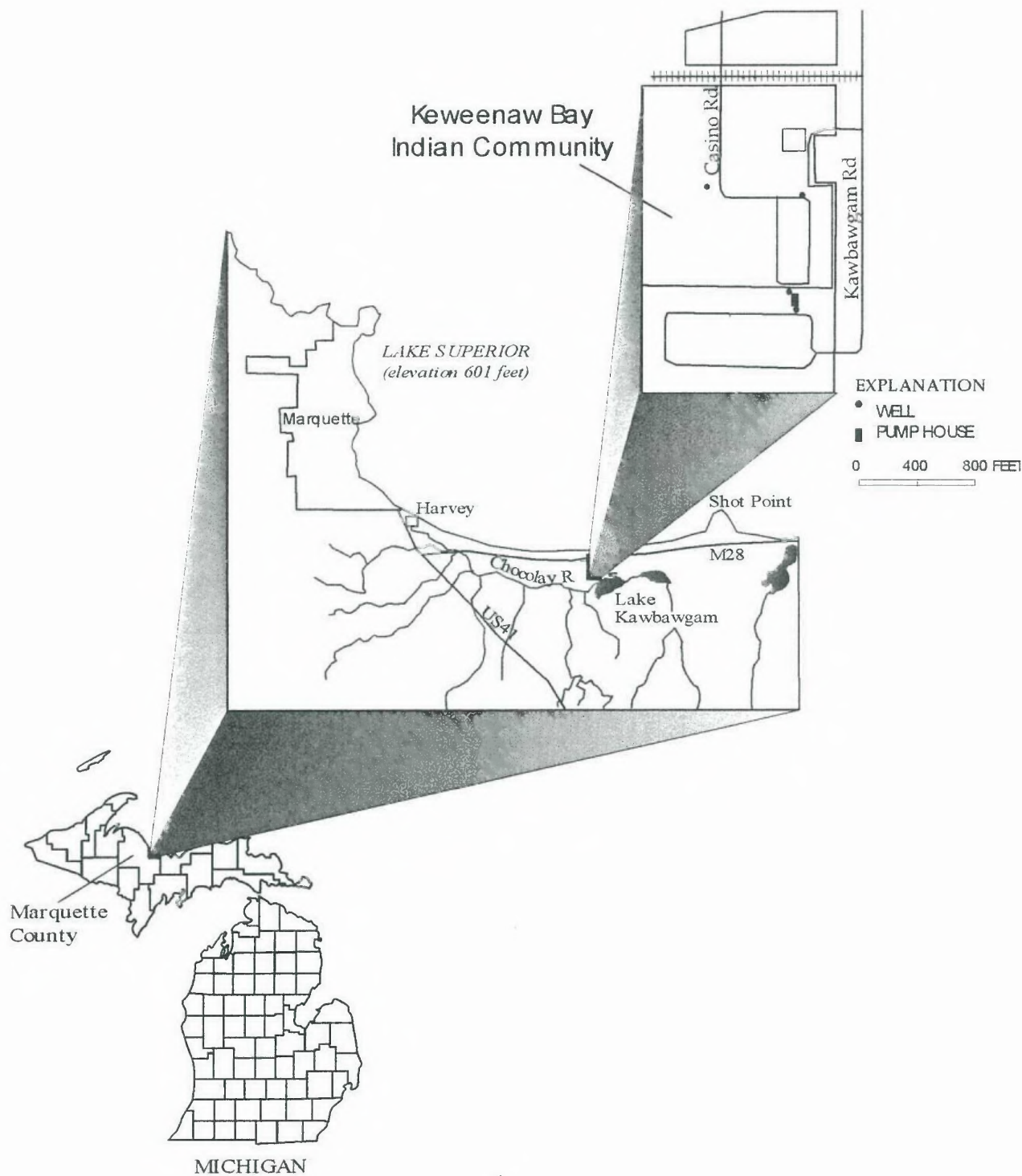
extent of the basal clay unit noted in proceeding sections of this study.

Soil types vary, but in the northern part of the study area, where KBIC Tribal lands are located, sand is prevalent, ranging from fine- to coarse-grained, extending to the subsurface contact with bedrock in some locations. In some places, beach ridge sands overlie finer-grained materials typical of morainal deposits. The terrain and soil composition change dramatically toward the southern part of the study area. Mixed sediments typical of till, including clays, are found in the area south of Mangum Road.

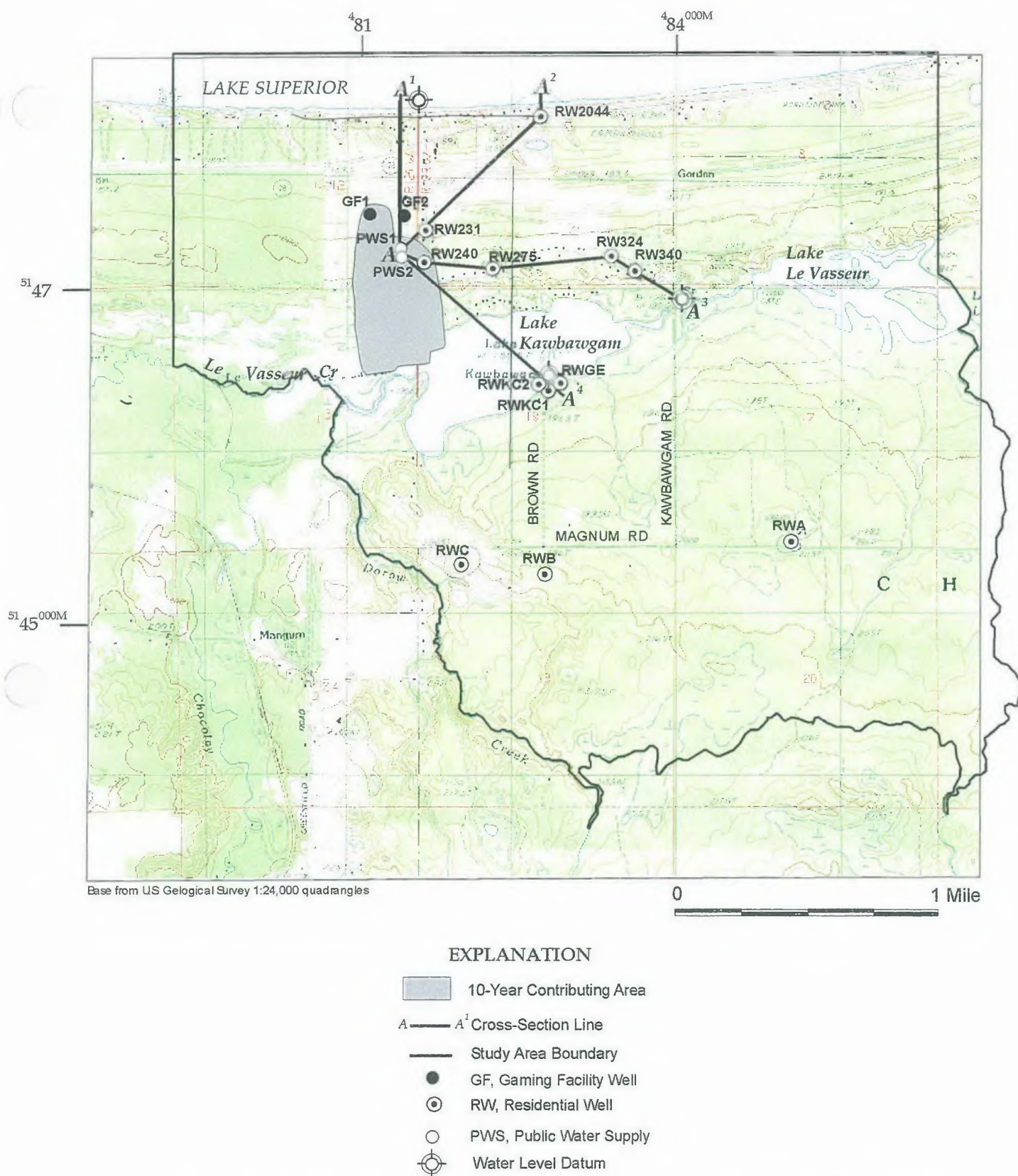
The areal extent and elevation of the Jacobsville Sandstone in the study area is poorly known because few wells have been completed in the formation. Jacobsville Sandstone outcrops at Shot Point, about four miles east of the study area, and at Harvey, about five miles west of the study area (fig. 1). The top of the Jacobsville Sandstone is about 110 to 115 ft below land surface at the KBIC public water supply wells, and rapidly slopes upward toward the southeast. Driller's logs of wells on the south side of Lake Kawbawgam (RWGE and RWKC2) and east of the intersection of Kawbawgam Road and Mangum Road (RWA) indicate only 1 to 4 ft of glacial and lacustrine deposits overlying the Jacobsville Sandstone (appendix A, fig. 2). Driller's logs also indicate the unconsolidated deposits thicken to at least 36 ft just south of the intersection of Brown Road and Mangum Road (RWB) and at least 64 ft near Dorow Creek (RWC)(appendix A, fig. 2). This bedrock low may be remnants of an erosional channel of the pre-glacial Chocolay River valley. Changes in land surface as a result of Pleistocene glaciation likely resulted in the river mouth shifting west to its present location in Harvey.

Vegetation types range from mature conifer and deciduous forests in the sandy or well-drained areas, to bushes and other plants in the wetland areas.

The climate of the study area is moderated due to proximity to Lake Superior. The nearest climatological data-collection site is at the Marquette County



**Figure 1.** Location of the Keweenaw Bay Indian Community, near Marquette, Michigan.



**Figure 2.** Modeled area plotted on USGS 1:24,000 quadrangle map showing 10-year contributing areas for public water-supply wells and gaming facility wells, Keweenaw Bay Indian Community study area.

Airport. Annual precipitation ranges from 21 to 47 inches, with a reported annual average of 32 inches (Twenter, 1981) to 34 inches (Grannemann, 1984).

### Methods of Investigation

The thickness, areal extent, and general lithologic characteristics of glacial and lacustrine deposits and the Jacobsville Sandstone were determined by evaluating driller's logs from two public water supply wells, one well supplying the gaming facility, and 13 domestic supply wells in the study area. Hydraulic properties of the Jacobsville Sandstone were determined by analyzing data from an aquifer test completed by Indian Health Services for KBIC in 1991.

A three-dimensional, finite-difference, ground-water flow-model of the study area was devised using the MODFLOW 96 code (McDonald and Harbaugh, 1996). The ground-water-flow model was then used in conjunction with the particle-tracking program MODPATH (Pollock, 1989) to delineate contributing areas of the two PWS wells supplying the housing community and the well supplying the gaming facility.

### HYDROGEOLOGY

In the KBIC study area, two geologic units are used as aquifers. Pleistocene glacial and lacustrine and till deposits ranging from 0 to 15 ft unconformably overlie the Precambrian Jacobsville Sandstone.

#### Lithology

The Jacobsville Sandstone is found at, or near, land surface throughout much of the northern part of Michigan's Upper Peninsula. In the Marquette area, the formation is mainly a reddish to reddish-brown feldspathic sandstone with intercalated lenses of red or gray conglomerate and reddish shale. Bleaching to a lighter color is typical along bedding planes, cracks, and other permeable parts of

the rock. The top of the formation is an erosional surface that is commonly fractured (Gair and Thaden, 1968). Glacial and lacustrine deposits comprised of clay- to sand-sized materials overlie the formation throughout the study area.

Driller's logs from Michigan Department of Environmental Quality (MDEQ) indicate that eight domestic supply wells within the study area were completed in the Jacobsville Sandstone (appendix A). At least one additional well exists, but no driller's log was located. All other known domestic wells in the study area are completed in glacial and lacustrine deposits and Appendix B contains driller's logs of wells that were used in this study. All wells referenced in this report are shown on figure 2.

A clay-rich layer up to 36 ft thick, which directly overlies the Jacobsville Sandstone, is indicated on driller's logs of several domestic supply wells (RW324, RWB, and RWC). However, little or no clay is indicated on driller's logs of several other wells, in particular those located in the area south of Lake Kawbawgam and north of Mangum Road (e.g., RWGE and RWKC2). Driller's logs of PWS well Nos. 1 and 2 show 8 and 7 ft, respectively, of clay or silty-clay directly overlying sandstone. As a result of sparse data, areal extent, thickness, and confining capabilities of any clay-rich unit within the glacial and lacustrine sediments are poorly defined.

The driller's log for PWS well No. 1 (appendix C) shows 106 ft of fine-grained silty sand, and sand with clay from 106 to 114 ft, overlying the Jacobsville Sandstone. The Jacobsville Sandstone consists of sandstone and gravel from 114 to 119 ft, firm sandstone from 119 to 128 ft, fractured sandstone from 128 to 130 ft, and firm sandstone from 130 to 145 ft. PWS well No. 1 is open to the formation from 124.5 to 145 ft. The driller's log for PWS well No. 2 (appendix C) shows 85 ft of clean sand, fine silty sand from 85 to 105 ft, and clay and silty sand from 105 to 112 ft overlying the Jacobsville Sandstone. The Jacobsville Sandstone consists of sandstone and gravel

from 112 to 117 ft, broken sandstone from 117 to 122 ft, firm sandstone from 122 to 125 ft, fractured sandstone from 125 to 127 ft, and firm sandstone from 127 to 138 ft. PWS well No. 2 is open to the formation from 123 to 138 ft. The gravelly interval present in both wells is probably conglomeratic as described by Gair and Thaden (1968).

Three hydrogeologic cross-sections, oriented approximately east-west (fig. 3), southeast-northwest (fig. 4), and southwest-northeast (fig. 5), illustrate information contained in the driller's logs, water levels of surface water bodies and wells, and an approximately-located land surface configuration.

### Aquifer Test and Analysis

Keweenaw Bay Indian Community and Indian Health Services began work on the community water supply system in Marquette County in 1990, beginning with installation of PWS well No. 1. To meet firm capacity requirements, PWS well No. 2 was installed in 1991. After installation of PWS well No. 2, Indian Health Services conducted an aquifer test using PWS well No. 2 as the pumping well and PWS well No. 1, located about 80 ft away, as an observation well. PWS well No. 2 was pumped at 100 gpm for 450 minutes, with drawdown measured in both wells. After 450 minutes of pumping, drawdown was

14 ft in the observation well. Following the pumping period, recovery was measured in both wells for 60 minutes. A drawdown-recovery curve was prepared, but no aquifer test analysis was completed. Data from the aquifer test is included as Appendix D.

To complete an analysis of aquifer test data, several standard assumptions must be made prior to data analysis. The assumptions are: flow is in the range of Darcy's law; water is discharged instantaneously from storage; and the aquifer is homogeneous and isotropic, has a constant thickness and a negligible slope, and is of infinite extent (Fetter, 1988). No aquifer is infinite, but most aquifers, including those used by KBIC, are areally extensive, and respond near the well as though they are uniformly thick, homogeneous and isotropic, and of infinite extent. Additionally, during the period of an aquifer test, most water is derived from storage, but pumpage has a negligible effect on long-term water levels within the aquifer.

To delineate the contributing area of the PWS wells, aquifer test data were analyzed using solutions for confined, leaky confined, and unconfined aquifers. Figure 6 illustrates the time-drawdown (displacement) curves with data analyzed using the methods of: (a) Theis (1935) for confined aquifers, (b) Hantush and Jacob (1955) for leaky-confined aquifers, and (c) Neuman (1974) for unconfined aquifers, respectively. Table 1 summarizes results of the aquifer test analyses.

**Table. 1** Results of aquifer test analysis for Keweenaw Bay Indian Community public water supply wells, Marquette County, Michigan.  
[NA, not applicable to analytical method.]

Analytical method	Estimated Saturated thickness (ft)	Radius from pumping well (ft)	Transmissivity (ft <sup>2</sup> /d)	Conductivity, (ft/d)	Storativity	Specific yield
Theis (1935)	30	80	880	30	$2.7 \times 10^{-5}$	NA
Hantush-Jacob (1955)	30	80	880	30	$2.4 \times 10^{-5}$	NA
Neuman (1974)	110	80	360	3	$4.3 \times 10^{-5}$	0.001

about 15.5 ft in the pumping well and about

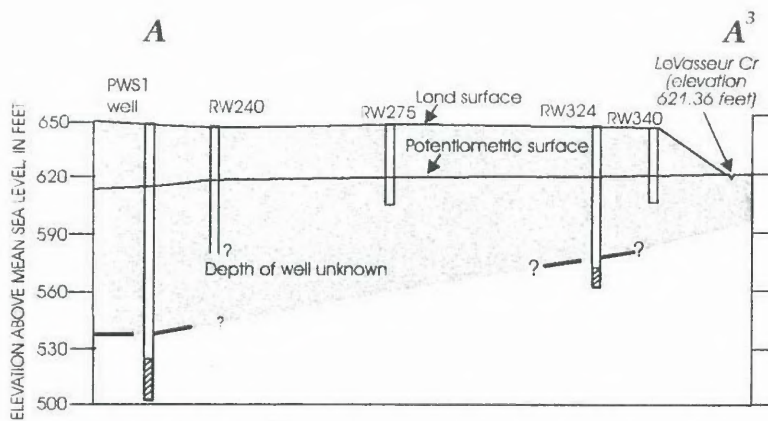


Figure 3. A-A<sup>3</sup>

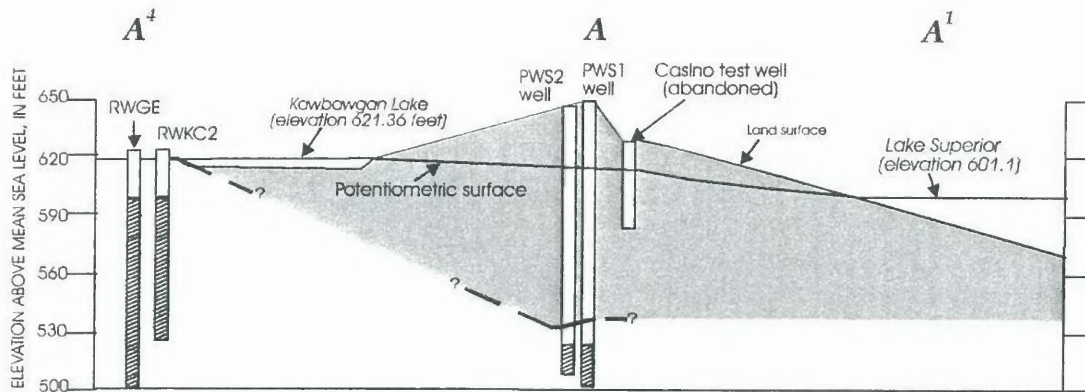


Figure 4. Section A<sup>4</sup>-A<sup>1</sup>.

Horizontal scale approx 2.6 inches = 1 mile  
Vertical scale greatly exaggerated

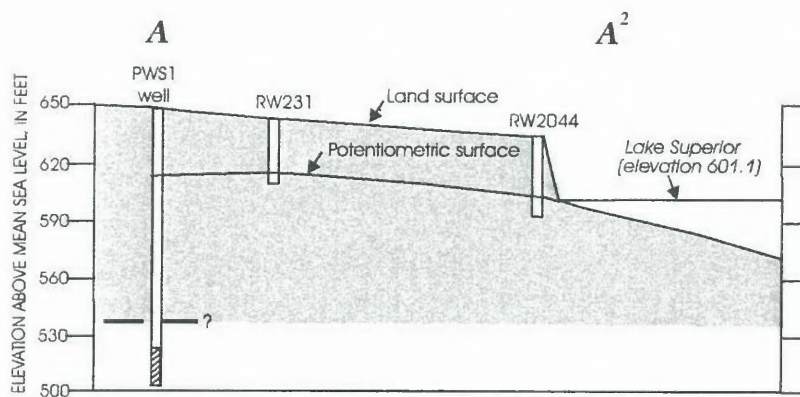





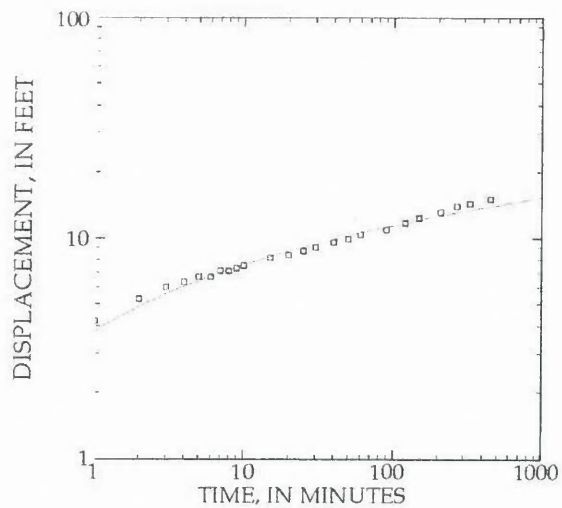
Figure 5. Section A-A<sup>2</sup>.

#### EXPLANATION

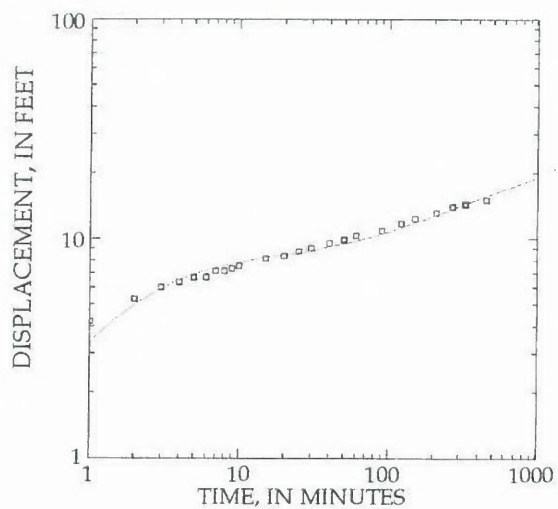
-  UNCONSOLIDATED GLACIAL AND LACUSTRINE SEDIMENTS
-  Borehole open to Jacobsville Sandstone Formation
-  CONTACT BETWEEN GLACIAL AND LACUSTRINE SEDIMENTS/  
JACOBSVILLE SANDSTONE FORMATION—Dashed where  
approximately located. Queried where insufficient data available

WELL RW324 is included to show geologic unit location only. Elevation of top of casing and depth to potentiometric surface is unknown

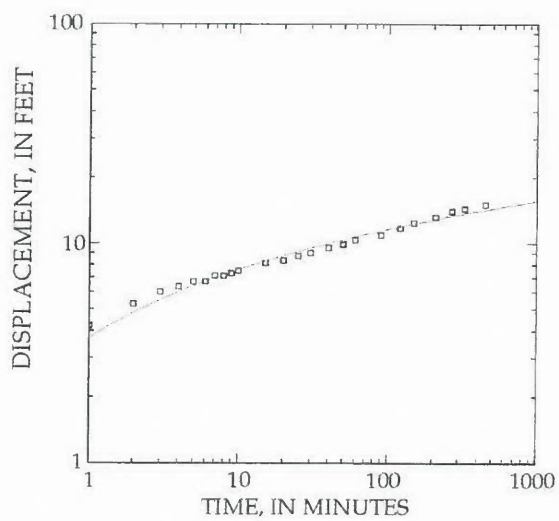
Figure 3, 4, and 5. Generalized hydrogeologic sections showing potentiometric surface and stratigraphic relations of Jacobsville Sandstone Formation and younger geologic units, Kawbawgan Lake area, Marquette County, Michigan. (Line of sections shown in figure 2.)



**Figure 6a.** Aquifer test analysis using the methods of Theis for confined aquifers.



**Figure 6b.** Aquifer test analysis using the methods of Neuman for unconfined aquifers.



**Figure 6c.** Aquifer test analysis using the methods of Hantush and Jacob for leaky-confined aquifers.

The upper part of the Jacobsville Sandstone is probably more productive than other parts of the formation. The formation is friable, highly fractured, and parts along bedding planes in outcrop, although it is known to become more massive at depth. The PWS wells, which are completed in the upper 26 to 31 ft of the formation, are much more productive than other wells completed in the formation throughout the Upper Peninsula of Michigan. The PWS wells can produce 100 gpm, but driller's logs of domestic supply wells completed in the formation in the study area record production rates of only 1 to 12 gpm (appendix A). Driller's logs of some domestic supply wells completed in the formation logs report full drawdown of water in the borehole after several hours of pumping at rates as low as 1 gpm. Several domestic supply wells with very low yields are located where the formation is near land surface. Because domestic supply wells in Michigan must be cased to a minimum of 25 ft below land surface (Michigan Department of Environmental Quality, 1994), these wells are effectively cased through the most productive zone of the formation.

Aquifer analysis using the methods of Theis (1935) and Hantush and Jacob (1955) use only the thickness of the productive upper part of the Jacobsville Sandstone (30 ft). Aquifer analysis using the methods of Neuman (1974) requires saturated thickness of the entire aquifer package, which includes about 80 ft of the glacial and lacustrine deposits overlying the Jacobsville Sandstone. A resultant total aquifer thickness of 110 ft was used for the unconfined analysis.

Results of the aquifer test analysis are not conclusive. Storativity values ranging from  $2.4 \times 10^{-5}$  to  $4.3 \times 10^{-5}$ , and a specific yield value of 0.001, are quite typical of a leaky-confined or confined aquifer (Freeze and Cherry, 1979). Displacement during the period from 10 to 100 minutes results in a flattened portion of the time-drawdown curve typical of an unconfined aquifer (Neuman, 1975). This relative flattening of the time-drawdown curve typically indicates

that delayed-response gravity-drainage of pore spaces in the de-watered part of the aquifer is taking place, resulting in a relative decrease in the drawdown until gravity drainage is complete. Typically, the delayed drainage part of an aquifer test is longer than 90 minutes in duration. Two conditions that could produce a similar response are the interception of a positive boundary such as a surface water body, or a temporary reduction in pumping rate, although nothing in the record suggests that either is applicable to this instance. A clay layer directly overlying the Jacobsville Sandstone, which is present in varying thicknesses in the PWS wells and several of the domestic supply wells in the study area, is absent from several other domestic supply wells, in particular those wells south of Kawbawgam Lake and north of Mangum Road. Although the confining layer probably creates leaky-confined or confined conditions near the PWS, the aquifer is likely unconfined elsewhere within the study area. Hydraulic conductivity in the range of 3 to 30 ft/day (ft/d) is typical of a semi-consolidated sandstone or medium-grained clean sand, respectively (Heath, 1982). Hydraulic conductivity of 30 ft/d in the Jacobsville Sandstone may be the result of fracture-flow and/or extensive leakage into the unit from the overlying glacial and lacustrine aquifer. A study of ground-water resources in Alger County (Vanlier, 1963), which is east of the KBIC study area, reported that most water movement in the Jacobsville Sandstone occurred along fractures and separations in bedding planes.

### Water Quality

The quality of water from wells completed in the Jacobsville Sandstone is often poor, with iron levels typically in excess of the USEPA secondary maximum contaminant level of 0.3 mg/L (Environmental Protection Agency, 1995). Water from the formation is also saline in a number of locations, although the source of the salinity is currently not known (D.B. Westjohn, USGS, oral commun.,

1999).

The water from the PWS wells is aesthetically more pleasing than water from the gaming facility well. During routine testing in May 1999, about 1 mg/L iron was present in water from the PWS wells, while 4 mg/L was present in water from the gaming facility well (Scott Helgeson, Indian Health Service, oral commun., 1999).

## DESCRIPTION OF WELLS

Water supply wells in the study area are completed in two aquifer units. The KBIC PWS wells are completed in the Jacobsville Sandstone, while a gaming facility well is completed in glacial and lacustrine deposits. Most residential wells are completed in glacial and lacustrine deposits at depths of 60 ft, or less. Several residences south of Lake Kawbawgam have wells completed in the Jacobsville Sandstone, although many of those wells are not currently in use.

## Community Water Supply System

The KBIC PWS system comprises two wells supplying about 40 residences. A third well supplies an adjacent gaming facility. An additional well (GF2) was drilled to supply the gaming facility but was never equipped with a pump. The two PWS wells, Nos. 1 and 2, are adjacent to a single pump house, where chlorine and fluoride are added prior to distribution (fig. 2).

PWS wells No. 1 and 2 were drilled under supervision of Indian Health Services in 1990 and 1991, respectively. Well No. 1 is six-inch diameter and completed to a depth of 145 ft and well No. 2 is eight-inch diameter and completed to a depth of 138 ft. Both wells are equipped with 100 gallon-per-minute (gpm) submersible pumps, although they are currently set to pump 50 to 53 gpm (Carl Rasanen, KBIC, oral commun., 1999). The wells are used as required, with one well typically held in reserve to meet firm capacity requirements. The PWS wells are completed in the Jacobsville Sandstone, and the gaming facility well is completed in glacial and

lacustrine deposits overlying the Jacobsville Sandstone.

Currently, no other PWS's are known to be withdrawing water from the Jacobsville Sandstone, due to poor yield and/or water quality (C. Thomas, MDEQ, oral commun., 1999). KBIC PWS wells near Baraga, completed in Jacobsville Sandstone have largely been replaced by surface water from the Baraga community water supply. The Sault Ste. Marie Chippewa tribe is currently developing a community water supply system near Sault Ste. Marie with multiple wells completed in the formation (D.B. Westjohn, oral commun., 1999).

## Residential Wells

Many residents living in the study area adjacent to tribal lands indicated that the quality of water from their domestic supply wells was either poor or non-potable, primarily due to the presence of high iron, tannin, and hydrogen sulfide. Most, if not all, domestic supply wells currently in use, north of Lake Kawbawgam, are completed in glacial and lacustrine deposits. Two residences on the south shore of Lake Kawbawgam had multiple wells completed in the Jacobsville Sandstone (RWKC1-2, RWGE), but none of the wells are currently in use because of poor water quality and low yield. These wells were cased through the upper 25 ft of Jacobsville Sandstone, which subcrops within 1 to 4 ft of the surface at this location, to meet MDEQ well construction guidelines (Michigan Department of Environmental Quality, 1994). Several wells at locations along Mangum Road (RWA, RWB, RWC) also were completed in the Jacobsville Sandstone, although the status of those wells is not currently known. Two of these wells are open through most of the upper part of the formation, but are located where 26 to 36 ft of clay-rich sediments directly overlie the formation. The clay-rich unit probably inhibits recharge from the overlying unconsolidated sediments to the Jacobsville Sandstone where the clay is semi-continuous.

## **SIMULATION OF GROUND-WATER FLOW**

### **Conceptual Model**

A conceptual model was devised to describe ground-water flow within the KBIC study area. The conceptual model includes the definition of aquifers and confining units, hydrologic boundaries, pumping stresses, and the presumed ground-water flow system.

Geologic units within the study area can be divided into distinct layers based on driller's logs of PWS and domestic water supply wells. The conceptual model for this study was defined as two hydrogeologic units, one consisting of glacial and lacustrine deposits, and the other consisting of the underlying Jacobsville Sandstone. Glacial and lacustrine deposits are thickest in the northwestern part of the study area, thinning considerably toward the south and east. Glacial and lacustrine deposits and upper 30 feet of the Jacobsville Sandstone are assumed to be permeable units while the remainder of the Jacobsville Sandstone is impermeable. Glacial and lacustrine deposits and upper 30 feet of the Jacobsville Sandstone are assumed to be hydraulically connected where the overlying clay layer is thin or absent. Two PWS wells, the gaming facility well, and several residential wells account for all known pumping stresses in the study area. Lake Superior, LeVasseur Creek, and Dorow Creek form the northern, eastern, and western hydrologic boundaries of the ground-water flow system in the study area, respectively. The southern hydrologic boundary is the upland reaches of Dorow and Le Vasseur Creeks.

### **Numerical Model**

A numerical model combines geologic and hydrologic information in order to represent observed conditions as simply and accurately as necessary to fulfill the objectives of a particular study. To simulate ground-water flow in the KBIC study area,

the updated U.S. Geological Survey modular three-dimensional finite-difference ground-water flow-model, MODFLOW-96, (McDonald and Harbaugh, 1996) was used. Because this model allows the simulation of steady-state ground-water flow in three dimensions, no ground-water storage or temporal discretization terms are required.

Ground water is withdrawn within the study area from the two PWS wells (typically one PWS well is operating, while the remaining well is on standby), the gaming facility well, and several residential wells. Only water withdrawn by the PWS wells (about 3,740 ft<sup>3</sup>/d) and the gaming facility well (estimated at about 4,000 ft<sup>3</sup>/d) was included in model simulations; domestic water withdrawals were assumed to be negligible. KBIC pumping records were used to compute withdrawal from PWS wells, and withdrawal from the gaming facility well was based on pump capacity and estimated water use at the gaming facility.

The southern model boundary was altered slightly from that in the conceptual model. The 700 ft (~213 meters) land surface contour (fig. 2), located about 1.5 miles south of Lakes Kawbawgam and LeVasseur, was chosen as the boundary. This boundary is more convenient than the basin boundary, and is far enough from pumping stresses to minimize edge effects in the ground-water flow model. The modeled area was divided to represent differences in recharge and hydraulic conductivity. The northern part is defined as that part of the study area north of Lakes Kawbawgam and LeVasseur, and south of Lake Superior. The southern part is defined as that part of the study area south of Lakes Kawbawgam and LeVasseur and north of the 700 ft land surface contour.

Several additional assumptions were made in order to complete the model. Ground-water flow occurs principally within the glacial and lacustrine deposits and upper 30 ft of the Jacobsville Sandstone, and flows approximately south to north toward Lake Superior, based on surface-water elevations taken from topographic maps of the area and

ground-water levels measured during this study. Ground-water flow is horizontal and both aquifers are assumed to be isotropic. Although vertical and horizontal hydraulic conductivities of geologic materials typically differ, the assumption of the model is that hydraulic conductivities do not vary within a particular plane. No water is assumed to flow into the glacial and lacustrine deposits from the eastern and western boundaries of the northern part of the modeled area. The following sections describe model development and characteristics.

#### *Model and Grid Layers*

Land surface information and some surface-water levels for most of the model area were obtained from USGS 7.5- and 15-minute quadrangle maps (Harvey and Skandia quads, and Gwinn quad, respectively). Potentiometric surface information was obtained when water levels in wells and some surface water features were surveyed into datum. Stratigraphic information was determined from available driller's logs for a number of wells within the study area.

The irregularly shaped model area is about 2.5 mile (mi) north to south and 3.2 mi wide east to west (fig. 7). This area is horizontally discretized into an equally spaced grid of cells in 101 columns and 108 rows. Each cell is 200 by 200 ft and represents *average* aquifer properties in the volume of aquifer represented by the cell. The model area is vertically discretized into four layers (fig. 8); initial simulations with two layers poorly represented water levels in the gaming facility well. The glacial and lacustrine deposits were divided into three layers to better represent that pumpage. At the gaming facility well, layer 1 extends from the potentiometric surface to 51 ft below land surface; layer 2 is comprised of the interval from 51 to 55 ft below land surface, which is the screened interval of the well; layer 3 is comprised of the remainder of the aquifer from 55 ft below land surface to the Jacobsville Sandstone contact. The

upper three layers, which thin considerably toward the eastern and southern parts of the study area, are primarily absent south of Lakes Kawbawgam and Le Vasseur. Layer 4 consists of the upper 30 ft of the Jacobsville Sandstone.

The potentiometric surface represents the top of the model (fig. 9). It was determined by contouring water level measurements surveyed into datum and additional water-surface altitudes listed for lakes and land surface contour intersections with streams on USGS 7.5- and 15-minute quadrangle maps. Separation of water table and potentiometric surfaces is impossible. Little or no notable variation exists, even where wells completed in both aquifer units, or wells and surface water features, are located in close proximity to one another. The contouring package SURFER (Golden Software Inc., 1994) was used to prepare the potentiometric surface map (fig. 9).

#### *Boundary Conditions*

Model boundaries are based on elevations of surface-water features and topographic information. Specified head boundaries, also known as constant head boundaries, are modeled by specifying the head value, which does not change during the simulation, in each cell. No-flow boundaries are modeled by specified flux boundaries where the specified flux is zero.

The entire northern boundary and the parts of the eastern and western boundaries formed by surface-water features consist of specified head cells for all layers of the model (fig. 7). Specified head cells were utilized for all model layers because the surface water bodies comprising those model boundaries either intersect both the glacial and lacustrine and Jacobsville

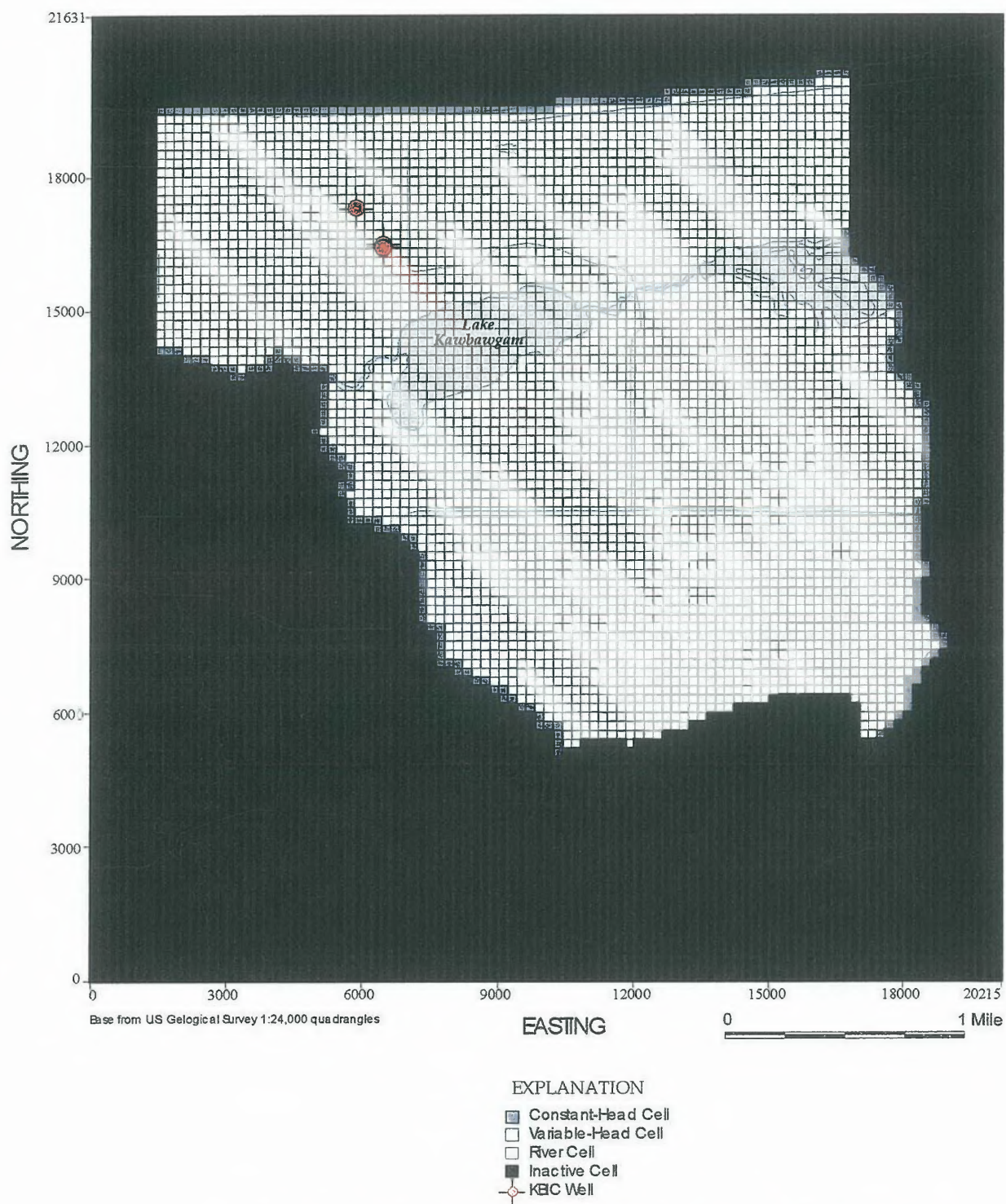
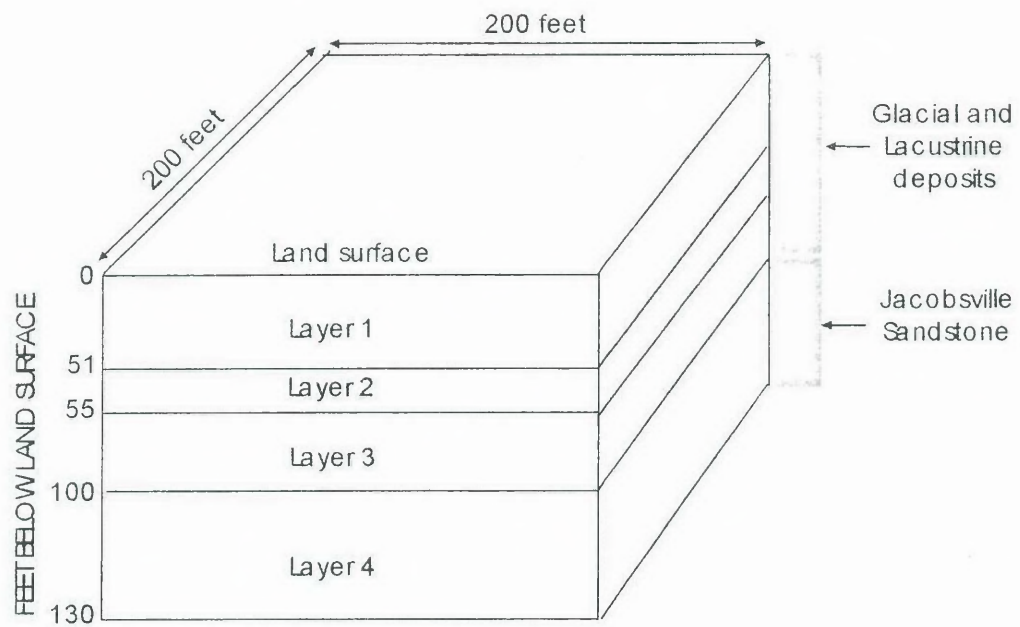
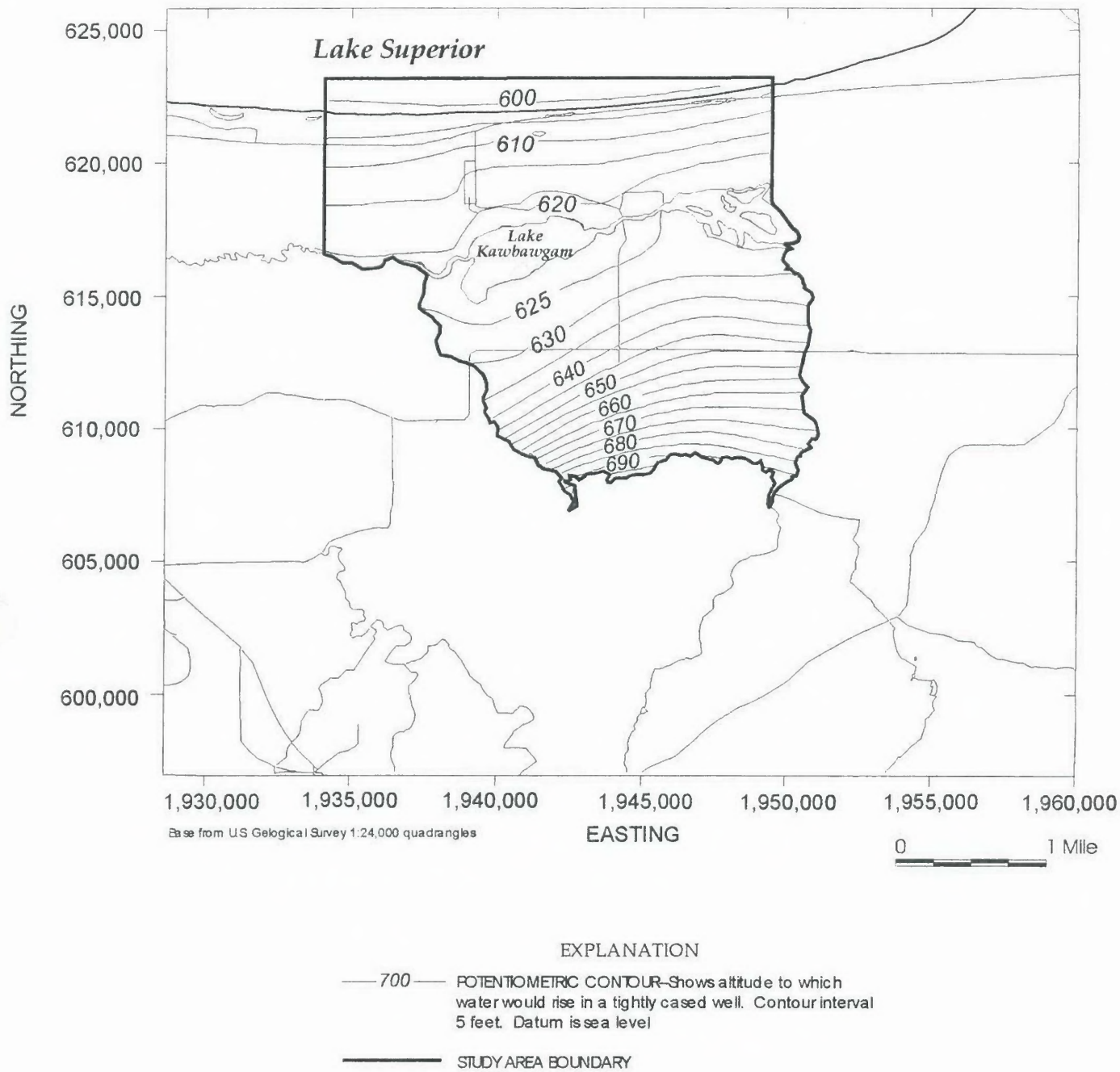


Figure 7. Modeled area showing MODFLOW grid, cell types, and boundaries, Keweenaw Bay Indian Community study area.



**Figure 8.** Schematic view of typical model cell, Keweenaw Bay Indian Community study area.



**Figure 9.** Modeled area showing potentiometric surface without effects of pumping public water supply or gaming facility wells, Keweenaw Bay Indian Community study area.

Sandstone aquifers, or are in close proximity to the Jacobsville Sandstone, permitting recharge of the aquifer unit to occur without restriction. Remaining portions of the eastern and western boundary in the northern part of the model area consist of no-flow cells. Within these areas, ground-water flow in the glacial and lacustrine deposits and Jacobsville Sandstone is parallel to the boundary and toward Lake Superior. The southern boundary in all layers was input as specified head or no-flow cells.

#### *Hydraulic Properties*

Hydraulic properties that were input for MODFLOW simulations include hydraulic conductivity and leakance, recharge, and streambed conductance for each layer. Hydraulic conductivity and leakance control ground-water flow through and between model layers, recharge rates determine the magnitude of water movement through the upper part of the modeled area, and streambed conductances control vertical flow of ground water between surface water bodies and aquifer unit(s) intercepted by the water bodies.

Hydraulic conductivities and effective porosity values used in the simulation are summarized in table 2. Hydraulic conductivities were calculated on the basis of the description of geologic units from drillers's logs and ranges of hydraulic conductivities (Fetter, 1988; Heath, 1982), along with aquifer test results for the PWS wells. Vertical hydraulic conductivity equal to 10 percent of the horizontal hydraulic conductivity was chosen as most representative of aquifer properties in the study area following several simulations using a variety of vertical and horizontal hydraulic conductivities. Effective porosity was chosen to realistically represent field conditions with mixed grain sizes typical of glacial and lacustrine deposits and the Jacobsville Sandstone, rather than those listed in various references for a particular grain size.

Simulated hydraulic parameters for layer 4, which represents the Jacobsville Sandstone, do not account for lower hydraulic conductivities thought to be typical of the formation below the upper 30 ft. An additional model layer could be used to represent the lower part of the formation,

**Table. 2** Hydraulic parameters used for MODFLOW simulation of ground-water flow, Keweenaw Bay Indian Community, Marquette County, Michigan.

[\*, simulation 1, both PWS wells pumping about 1,870 ft<sup>3</sup>/d; Kx, horizontal hydraulic conductivity; Kz, vertical hydraulic conductivity; 4<sup>N</sup>, cells north of Lakes Kawbawgam and Le Vasseur; 4<sup>S</sup>, cells south of Lakes Kawbawgam and Le Vasseur; Southern boundary cells no-flow in all simulations 1

Layer		Simulation 1*		Simulation 2		Simulation 3	
	Effective porosity (in percent)	Kx (ft/d)	Kz (ft/d)	Kx (ft/d)	Kz (ft/d)	Kx (ft/d)	Kz (ft/d)
1,2	10	20	1	20	2	40	4
3	10	20	1	5	.5	5	.5
4 <sup>N</sup>	5	1.5	.075	30	3	30	3
4 <sup>S</sup>	5	1.5	.075	15	1.5	15	1.5

but permeability is probably so low that little water moves upward into the productive part of the formation. Leakances were calculated on the basis of layer thickness and vertical hydraulic conductivity of each layer (McDonald and Harbaugh, 1988, p. 5-13). Recharge was assumed to vary over the model area depending on composition of the glacial and lacustrine deposits. In the northern part of the modeled area, where these deposits consist almost entirely of sand, recharge is estimated to be 15 inches per year (in/yr). A previous study of the Sands Plains aquifer in Marquette County, which included ground-water flow model, also used recharge of 15 in/yr (Grannemann, 1984). In the southern part of the model area, where clay-rich tills make up most of the glacial deposits or the Jacobsville Sandstone subcrops near the surface, recharge was reduced to 2 in/yr.

In MODFLOW, streambed conductance is the product of the hydraulic conductivity of the streambed materials, stream length, and stream width, divided by the streambed thickness (McDonald and Harbaugh, 1988, p.6-5). Streambeds are assigned a thickness of 1 ft and a hydraulic conductivity of 5 ft/d, and lakebeds are assigned a hydraulic conductivity of 1 ft/d.

### Model Calibration

Model calibration is the process of reducing the difference between simulated and measured heads by adjusting the model input parameters. Calculation of the Root Mean Squared Error (RMSE), which is the average of squared differences between measured and simulated heads, provides a means to compare results of different simulations (table 3). Model fit and sensitivity were investigated by varying hydraulic conductivity in the aquifer units, porosity of the glacial and lacustrine aquifer, and recharge. Variations in some of the parameters resulted in little change to the model (lower sensitivity) while others, e.g., horizontal hydraulic conductivity, resulted in more significant changes (higher sensitivity). The calculated elevations of the

potentiometric and water table surfaces were observed while parameters were adjusted, and results were compared with observed heads. Although additional simulations were completed, the three included in table 3 utilize a range of hydraulic parameters thought to be representative of the study area.

Simulation 1 matched measured heads within about 6 ft. Although this simulation matches many heads closely, heads in three wells completed in the Jacobsville Sandstone on the south side of Lake Kawbawgam (RWKC1-2, RWGE) are particularly poorly simulated. In simulation 1, vertical hydraulic conductivities were assumed to be 5 percent of the horizontal values and layer 4 utilized hydraulic conductivity values that were similar to those obtained when the aquifer test data for the PWS wells was analyzed as unconfined (table 1).

Simulation 2 matched measured heads in RWKC1-2 and RWGE more accurately, and in PWS wells less accurately, than simulation 1. However, water levels in the PWS wells were measured after the pumps had been turned off for several hours, allowing the aquifer to return to unstressed conditions; consequently, simulated heads in these wells during pumping simulations are not particularly useful. In simulation 2; vertical hydraulic conductivities were assumed to be 10 percent of the horizontal values; layer 3 is assigned lower hydraulic conductivity values than layers 1 and 2, which is consistent with the interpretation of this layer as confining the underlying Jacobsville Sandstone aquifer in the area of the PWS wells; layer 4 in the northern part of the study area is assigned hydraulic conductivity values obtained when the aquifer test data for the PWS wells was analyzed as leaky-confined (table 1); and hydraulic conductivity of Layer 4 in the southern part of the study area is reduced by 50 percent.

**Table. 3** Results of MODFLOW simulation of ground-water flow, Keweenaw Bay Indian Community, Marquette County, Michigan.  
[RMSE, root mean squared error; multiple locations shown for Lake Kawbawgam.]

Location	Observed heads, (feet)	Simulation 1 Calculated head (feet)	Simulation 2 Calculated head (feet)	Simulation 3 Calculated head (feet)
RWKC1	622.06	628.25	623.0	623.0
RWKC2	621.58	624.34	621.8	621.8
RWGE	621.80	626.57	622.7	622.6
RW2044	604.38	603.89	604.1	603.4
RW231	616.96	615.53	616.6	615.1
RW240	618.20	616.83	617.9	616.6
RW275	619.32	618.88	619.5	618.6
RW340	620.30	620.80	621.0	620.2
PWS well 2	610.00	609.82	617.2	615.9
PWS well 1	610.00	609.04	615.5	614.2
Casino well (abandoned)	614.72	613.41	614.4	612.9
Lake Kawbawgam	621.06	621.06	621.1	621.1
Le Vasseur Creek at Bridge	621.36	621.80	621.8	621.7
Unnamed lake south of M28	607.00	606.46	606.8	605.7
Lake Kawbawgam	621.00	621.16	621.2	621.1
Lake Kawbawgam	621.06	621.05	621.0	621.0
RMSE, all wells included		2.19	2.31	2.04

Simulation 3 also matched measured heads in RWKC 1-2 and RWGE more accurately than simulation 1. Simulation 3 did not match heads in *some* residential wells as well as simulation 2 did, particularly for those wells down-gradient from the PWS wells. Heads in several other wells however, are matched more accurately than simulation 2. Simulation 3 differs from simulation 2 in that hydraulic conductivity of layers 1 and 2 is doubled.

The RMSE is lowest for simulation 3. Results of simulation 2 and 3 (table 3) were chosen as most representative of the aquifer system in the study area; simulated heads matched observed heads more accurately than in other simulations; and hydraulic parameters are thought to accurately represent conditions in the study area. No-flow cells were used as the southern boundary cells, eliminating effects that specified-head cells could have on the model in that part of the study area where the aquifer system is least understood.

A number of model cells went dry in layers 1, 2, and 3 during *all* simulations, both south of Lake Kawbawgam and near the eastern boundary in the northern part of the study area. Layer 1 has the largest number of dry cells (fig. 10), although layers 2 and 3 also have some dry cells in the same areas. Dry cells occur in areas where glacial and lacustrine deposits are thin, and the Jacobsville Sandstone subcrops near the surface, or where thick, clay-rich materials directly overlie the Jacobsville Sandstone. Little recharge of the Jacobsville Sandstone aquifer occurs in these areas, with most precipitation running off to surface water bodies in areas where bedrock is near the surface. To verify that dry cells accurately represent hydrologic conditions of the study area, a recharge of 15 in/yr was also applied to the southern part of the study area during one of the simulations. Although this method wetted some cells close to the south shore of Lake Kawbawgam, it had little effect on the rest of the dry cells and resulted in a poor match between calculated and observed heads elsewhere in the model. In simulations included in table 3, recharge

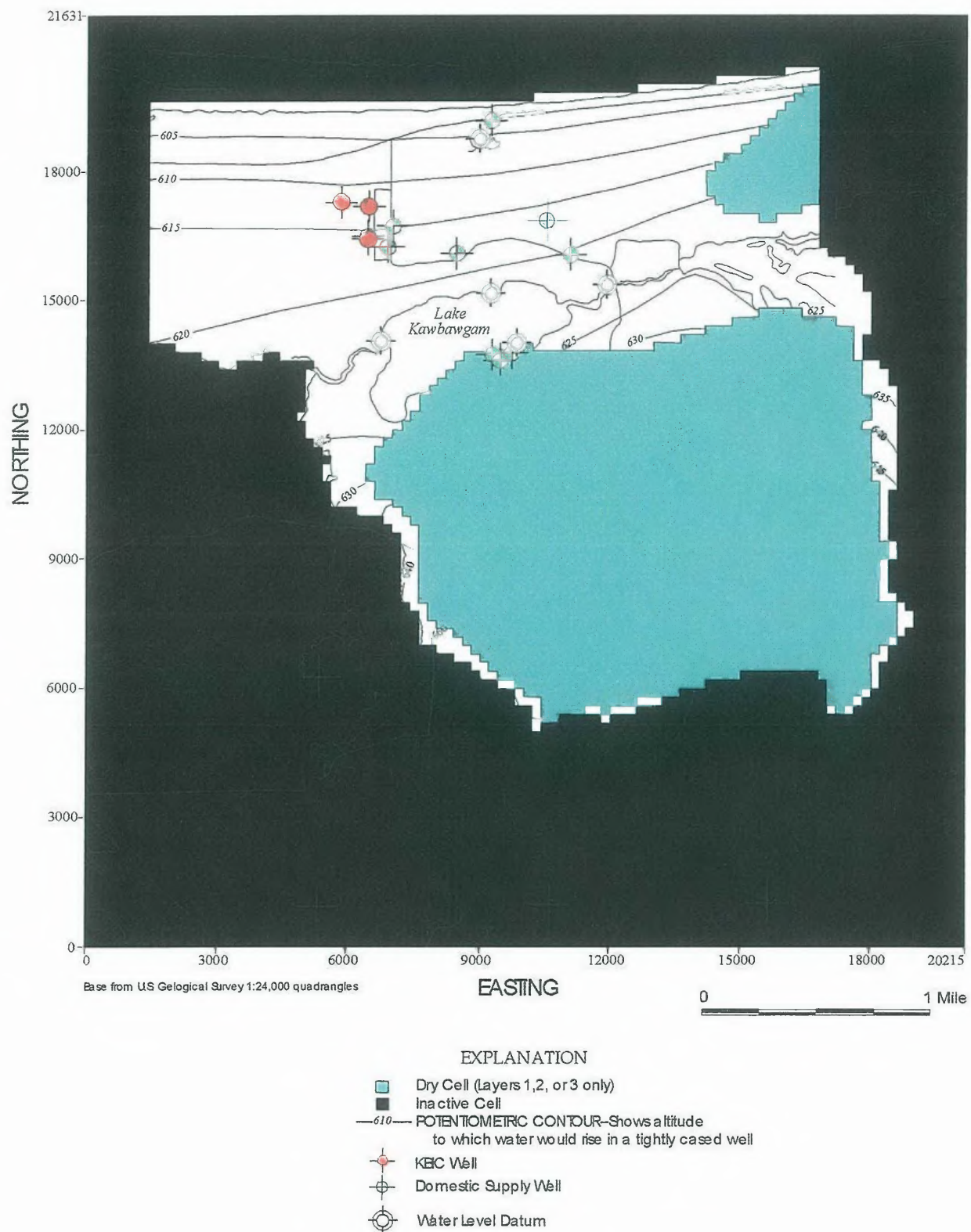
of 2 in/yr was used in the southern part of the study area and 15 in/yr was used in the northern part of the study area.

## DELINEATION OF CONTRIBUTING AREA

The particle-tracking program MODPATH (Pollock, 1989) can be combined with flow calculated by MODFLOW in each cell to determine the area(s) contributing water to well(s). MODPATH uses a semi-analytical particle-tracking scheme that allows a hypothetical water particle to be tracked as it moves from cell to cell through a steady-state, three-dimensional flow system. Particle paths, and the locations where they enter and leave the simulated ground-water flow system, approximate ground-water flow paths in the aquifer. Particle tracking describes the advective movement of ground water and does *not* incorporate the effects of diffusion, dispersion, and degradation. Therefore, particle tracking is not intended as a substitute for modeling the transport of dissolved chemicals in the ground-water system.

These hypothetical water particles can be tracked down- or up-gradient (referred to as "forward" or "backward" tracking, respectively) until they exit the aquifer, or reach a specified stopping location. In this study, water particles were placed along the faces of each cell containing a community well. These particles were then backward tracked in time through the ground-water flow system for a travel time of 10 years, as specified by USEPA.

When MODPATH was used in conjunction with the results of MODFLOW 96 simulations 1 to 3, they defined similar 10-year contributing areas. As input parameters were varied, some changes to size and shape of the contributing areas occurred; when effective porosity of the glacial and lacustrine aquifer was increased, the size of the contributing areas was reduced slightly; when hydraulic conductivity in the glacial and lacustrine aquifer is increased, contributing areas



**Figure 10.** Modeled area showing dry cells in Layer 1, Keweenaw Bay Indian Community study area.

constrict and extend several hundred feet further south; little difference was noted when hydraulic conductivity in the Jacobsville Sandstone aquifer was reduced, and no difference was noted when cell types comprising the southern boundary were changed from no-flow to specified head.

Contributing areas of the PWS and gaming facility wells were obtained by combining results of simulation 2 and 3 (table 3). The contributing area of the gaming facility well was delineated after simulations indicated interference with the PWS wells. The composite 10-year contributing area for the PWS and gaming facility wells comprises about 0.2 mi<sup>2</sup>. Sub-surface areas that contribute water to wells are known as the zone of contribution areas. Figure 11 is a section view of the zone of contribution for the PWS wells and figure 12 is a section view of the zone of contribution for the gaming facility well. The zone of contribution for the PWS wells extends from the Jacobsville Sandstone upward into glacial and lacustrine deposits, reaching land surface about 1,200 ft south of the wells and extending into Lake Kawbawgam. The zone of contribution for the gaming facility well is entirely within glacial and lacustrine deposits, extending upward to land surface at the well head and south about 3,300 ft. Figure 2 shows the 10-year contributing areas plotted on the USGS 1:24,000 Harvey and Skandia quadrangle maps that include the KBIC study area.

### Model Limitations

The ground-water flow model for the KBIC study area was devised to simulate regional steady-state response of the flow system in the study area to ground-water withdrawal by PWS wells. Hydraulic properties in the aquifers were assumed to be isotropic only within the horizontal plane. Vertical variations in aquifer properties within layers, and any variation in heads or flow within the aquifers, are not represented in the model.

Each grid cell represents average hydrologic and hydraulic properties in the volume of aquifer represented by the grid cell. Thus variations in properties within individual cells cannot be represented. Likewise, flow over distances smaller than the dimensions of the grid cell cannot be accurately represented. Additional geologic and hydrologic data and finer discretization of the model would be needed to simulate smaller-scale flow systems.

Simulated well pumpage is assumed to come from the centers of the grid cells. Accuracy of layer surfaces and hydraulic conductivity estimates are limited by available data.

The bottom of layer 4 in the model is considered impermeable, based primarily on the low permeability of the Jacobsville Sandstone in parts of the formation where it is un-weathered and fractures are not present. For this study, all of the formation below the upper 30 ft of was assumed to meet this criterion.

Model simulations are restricted to steady-state conditions. All stresses within, and inputs to the system, including well pumpage and recharge, remain constant throughout the simulation. No net gain or loss of flow is simulated in the system and no changes in storage occur. This model in its current form cannot be used to simulate transient-flow conditions.

The accuracy of particle-tracking simulations is limited by the accuracy of the numerical model on which the simulations are based, estimates of the effective porosity of the flow system, and approximation of the cell flow velocities to local ground-water flow velocities. Additionally, the particle-tracking program considers ground-water flow by advection only. If the effects of dispersion were included, contributing areas would be larger. Because the model does not specifically describe flow through fractures, ground-water flow and travel times in areas of the Jacobsville Sandstone where fractures exist may *not* be accurately represented.

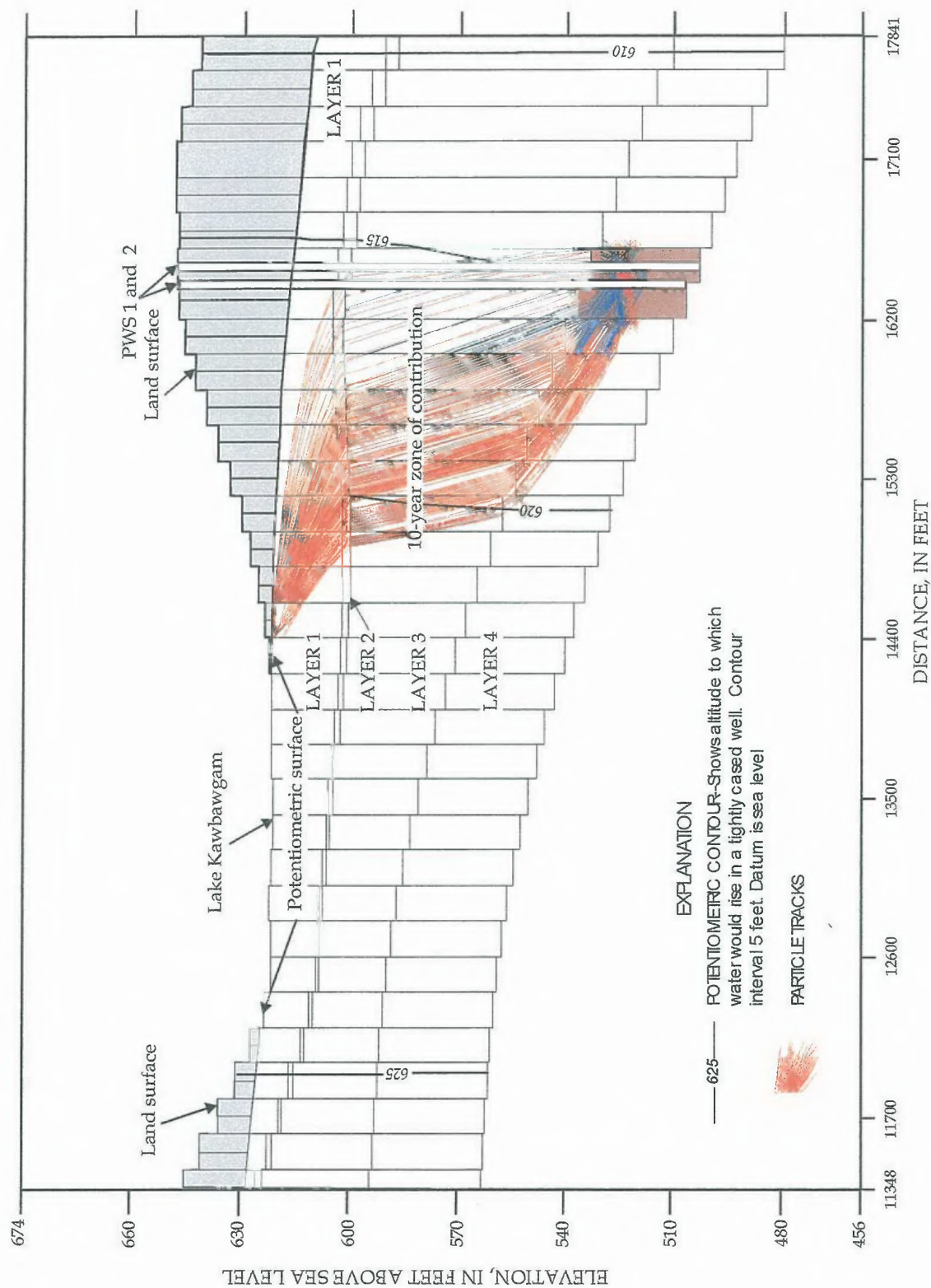


Figure 11. North-south section view of contributing area to Keweenaw Bay Indian Community public water-supply wells.

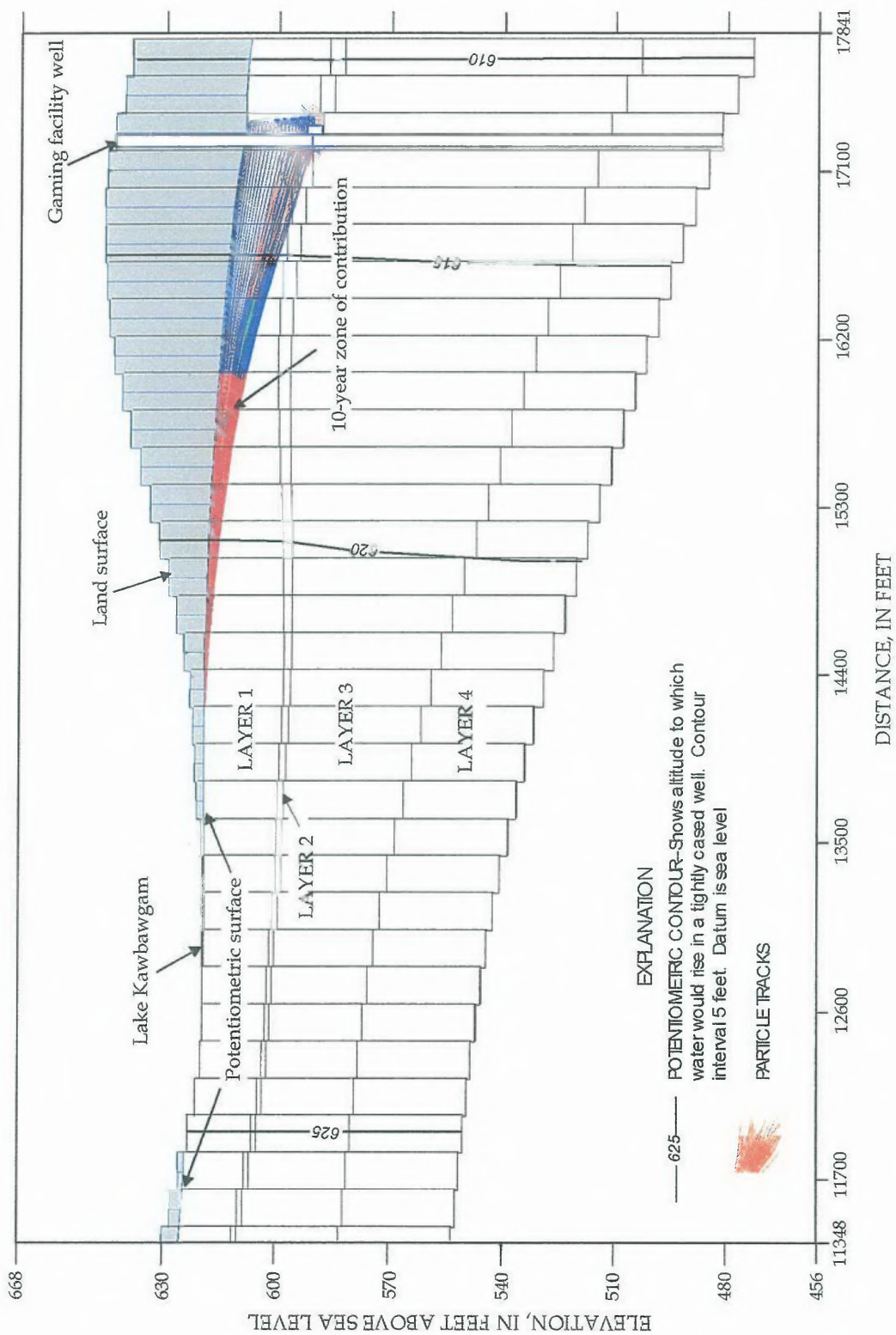


Figure 12. North-south section view of contributing area to Keweenaw Bay Indian Community gaming facility well.

## SUMMARY

Keweenaw Bay Indian Community (KBIC) in Marquette County, Michigan has two public water supply (PWS) wells completed in the Jacobsville Sandstone Formation. The PWS wells can pump much more water than other wells completed in the formation throughout the Upper Peninsula of Michigan. In 1998, an U.S. Environmental Protection Agency grant to develop a wellhead protection plan (WHPP) for the PWS wells was awarded to KBIC. As part of the WHPP, U.S. Geological Survey (USGS) delineated the 10-year contributing areas for the PWS wells and KBIC completed the contaminant source inventory using the contributing area delineated by USGS.

*Thickness, areal extent, and general lithologic characteristics of the Jacobsville Sandstone and glacial and lacustrine deposits were determined by evaluating driller's logs from two PWS wells, one well supplying a gaming facility, and 13 domestic supply wells located in the study area. Water levels of surface water bodies and ground-water wells were surveyed into datum, and additional surface-water levels were obtained directly from topographic maps. Three hydrogeologic cross-sections intersecting at the KBIC PWS wells were prepared using known data. An aquifer test completed by Indian Health Services in 1991 was analyzed to obtain hydraulic characteristics, and the above information*

*was input into the USGS three-dimensional ground-water flow-modeling program, MODFLOW-96. To calibrate the flow model, several simulations were run using a range of hydraulic conductivities, recharge rates, porosities, and cell types at the southern study area boundary. Two simulations were chosen as representative of the ground-water flow system in the study area. The chosen simulations best matched measured water levels.*

*The area contributing water to the PWS and gaming facility wells over a period of 10 years was delineated using the particle-tracking program MODPATH in conjunction with the ground-water-flow model prepared in MODFLOW-96. The gaming facility well was also delineated due to potential interference with PWS wells. To conservatively delineate the 10-year contributing area for the KBIC wells, contributing areas from the chosen simulations were combined to produce a composite area. The combined 10-year contributing areas comprise about 0.2 mi<sup>2</sup>. The zone of contribution for the PWS wells extends from the Jacobsville Sandstone upward into glacial and lacustrine deposits, reaching land surface about 1,200 ft south of the wells and extending into Lake Kawbawgam. The zone of contribution for the gaming facility well is entirely within glacial and lacustrine deposits, extending upward to land surface at the well head and about 3,300 ft south.*

## REFERENCES CITED

- Environmental Protection Agency, 1993, Guidelines for delineation of wellhead protection areas, EPA-440/5-93-001, p. 1-2.
- Environmental Protection Agency, 1995, Drinking water regulations and health advisories, Office of Water.
- Farrand, W.R., and Drexler, C.W., 1985, Late Wisconsinan and Holocene history of the Lake Superior Basin, in Karrow, P.F., and Calkin, P.E., eds., Quaternary Evolution of the Great Lakes, Geological Association of Canada Special Paper 30, p. 18-32.
- Fetter, C.W., 1988, Applied Hydrogeology, Merrill Publishing, 592 p.
- Freeze, A.R., and Cherry, J.A., 1979, Groundwater, Prentice-Hall, Inc., 604 p.
- Gair, J.E., and Thaden, R.E., 1968, Geology of the Marquette and Sands quadrangles,

- Marquette County, Michigan, U.S. Geological Survey, Professional Paper 397, 77 p.
- Golden Software, Inc., 1994, SURFER for Windows, 446 p.
- Grannemann, N.G., 1984, Hydrogeology and effects of tailings basins on the hydrology of Sands Plains, Marquette County, Michigan, U.S. Geological Survey, Water-Resources Investigations Report 84-4114, 98 p.
- Hantush, M.S., and Jacob, C.E., 1955, Plane potential flow of groundwater with linear leakage: American Geophysical Union Transactions, v. 16, p. 519-524.
- Heath, R.C., 1982, Basic ground-water hydrology, U.S. Geological Survey, Water-Supply Paper, no. 2220, 81 p.
- McDonald, M.G., and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 6, Chap. A1, 576 p.
- McDonald, M.G., and Harbaugh, A.W., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.
- Michigan Department of Environmental Quality, 1994, Michigan water well construction and pump installation code, 1994 revision, 72 p.
- Neuman, S.P., 1974, Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response: Water Resources Research, vol. 10, no. 2, p. 303-312.
- Neuman, S.P., 1975, Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response: Water Resources Research, vol. 11, p. 329-342.
- Pollock, D.W., 1989, Documentation of computer programs to compute and display pathlines using three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 89-381, 188 p.
- Theis, C.V., 1935, The relation between lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: American Geophysical Union Transactions, vol. 16, p. 519-524.
- Twenter, F.R., 1981, Geology and hydrology for environmental planning in Marquette County, Michigan, U.S. Geological Survey, Water-Resources Investigations Report 80-90, 44 p.
- Vanlier, K.E., 1963, Reconnaissance of the ground-water resources in Alger County, Michigan: Michigan Geological Survey Water Investigation 1, 55 p.

## **Appendix 3**

U.S. Geological Survey Source Water Assessment, PWSID # EPA5293303, Kawbawgam Road, Michigan Source Water Assessment Report 72

PWSID#: EPA5293303  
Kawbawgam Road  
Community Water System  
Marquette County  
Skandia Quadrangle



**Importance of Safe Drinking Water:** In 1996, Congress amended the Safe Drinking Water Act and provided resources for state agencies to conduct source water assessments by identifying source water areas (SWA), analyzing the sensitivity of the source to natural conditions, conducting contaminant source inventories, and determining the susceptibility of the source to potential contamination. Delineations, sensitivity analyses, contaminant inventories, and susceptibility determinations comprise a "source water assessment." The U.S. Geological Survey (USGS) has compiled information from the area around the public water supply wells that supply the Kawabawgam Road community. This information includes available water-quality data and potential contaminant sources, and describes the ability of the environment to protect the water supply from contamination. This report summarizes those findings.

**Water Supply Information:** According to records of the Indian Health Service (IHS) and the Kawabawgam Road supply, between 1997 and 2001, water was supplied from two wells at a rate of less than 10,000 gallons per day (Rasanen, 2002). The source of water for the supply is a sandstone bedrock aquifer. The aquifer is covered by a layer of sand with some areas of silty sand and (or) clay and silt. The aquifer is potentially susceptible to contamination by a variety of sources, including point sources (such as leaking underground storage tanks and non-point sources (such as agricultural chemicals). Additional information about potential sources of contamination can be found at:

<http://www.epa.gov/OGWDW/swp/sources1.html>

**What are the Potential Contaminant Sources?** Near the wells, the land is used for commercial purposes and for residential development. South of the wells and the residential area, the land is classified as wooded and wetlands. The southern most part of the area that contributes recharge to the wells is under Kawabawgam Lake. Some lawn chemicals are probably applied to nearby lawns. Each of the residences supplied by the wells has a septic system, as does the adjacent casino and housing authority building. The casino also has a standby generator with fuel storage on-site. The parking lot for the casino is a potential source for runoff, including fuels and other fluids leaking from vehicles. Within the 10-year time of travel to the wells (SWA) identified by the USGS (Weaver and others, 2000) there are no regulated facilities, or facilities with permits

to store, handle, or discharge potential contaminants. There are 14 septic systems and a casino, all point sources, and part of the casino parking lot, which is a non-point source. The susceptibility of the source water to contamination is considered low.

**What is the Effect of the Environmental Setting?** From Weaver and others (2000): "The source of water for the supply is the Jacobsville Sandstone, a bedrock aquifer. The aquifer is covered by a layer of sand with some areas of silty sand and (or) clayey sand. The upper part of the Jacobsville Sandstone is probably more productive than other parts of the formation. The formation is friable, highly fractured, and parts along bedding planes in outcrop, although it known to become more massive at depth. The Kawabawgam Road wells are completed in the upper 26 to 31 feet of the formation, and are much more productive than other wells completed in the formation throughout the Upper Peninsula of Michigan. The Kawabawgam Road wells are capable of producing as much as 100 gallons per minute." Static water levels are about 35 feet below the surface in the area. Because of the relatively high permeability of overlying sands throughout the source-water area, the geological susceptibility of the source water to contamination is considered high.



**What is the Likelihood that Contaminants May Reach this Water Supply?** In 1998, to determine the likelihood that contaminants might reach this water supply, and to begin planning a wellhead protection program, the Keweenaw Bay Indian Community (KBIC) was awarded a source-water protection grant from the U.S. Environmental Protection Agency (USEPA) to complete a wellhead protection plan (WHPP). As part of the WHPP, USGS delineated a 10-year contributing area for the public water supply wells using a modular ground-water flow model. The model calculated the rate of water movement downward from the land surface to the aquifer, and the rate of water movement horizontally as saturated flow through the aquifer. The results of these calculations were used to trace the path of water backward, from the open part of the well where water is withdrawn, to the land surface where the water would have originated. Within the SWA described in this report, calculations of travel time and distance were made using information from 13 water-well logs. These calculations, the results of the model, and the available well construction information indicate that the susceptibility of the source water to contamination is low.

**How Can I Act on this Information?** The actual susceptibility of the drinking water source of a water supply depends on a number of contributing factors, some of which are only slightly related. Sensitivity is determined from the natural setting of the source and identifies the natural protection afforded to the source water. Susceptibility is determined by identifying those factors within the community's SWA that may pose a risk to the source water. The susceptibility determination provides information with respect to facilities within the SWA or land areas within the SWA that should be given greater priority and oversight in the implementation of a drinking water protection program. The information presented in this source-water assessment provides background information that interested parties can use to develop a source-water protection program. This information can be used to :

1. Increase local awareness of the source of drinking water;
2. Recognize the factors affecting drinking water quality;
3. Focus available resources on sites and areas of greatest concern; and
4. Make land-use decisions compatible with maintaining clean water.

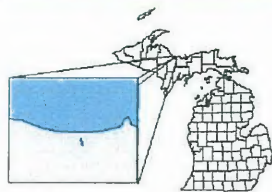
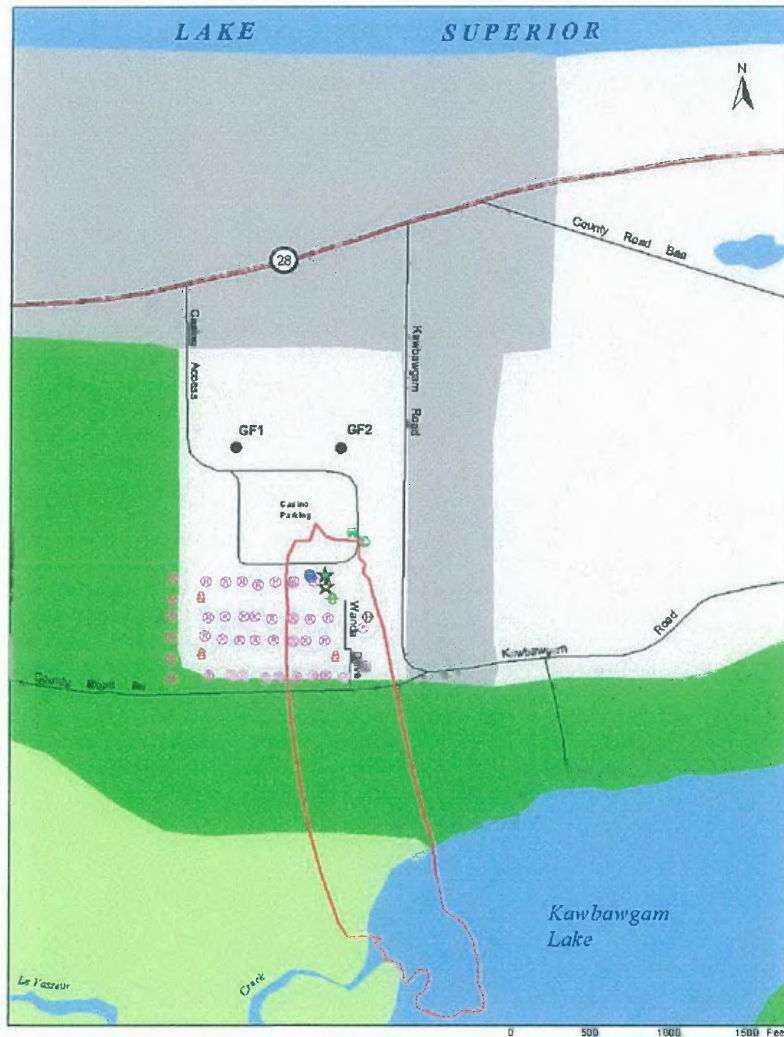
The Kawbawgam Road community should assemble a team to assist in the development and implementation of a source-water protection program that uses this assessment to further protect the Kawbawgam Road SWA. For more information on developing a local source-water protection program, visit:

<http://www.epa.gov/safewater/protect/assessment.html>.

For questions or comments concerning this assessment, contact the Keweenaw Bay Indian Community Natural Resources Department, Office of Water Quality at (906) 524-5757, extension 15.



Source Water Assessment  
PWSID#: EPA5293303  
Kawbawgam Road  
Michigan Source Water Assessment Report 72



- Explanation**
- ★ Public Water Supply (PWS) - 1
  - ★ PWS - 2
  - GF, Gaming Facility Well
  - Casino Temporary 1 inch Line Supply
  - Casino Parking Hydrant
  - PWS Septic
  - Casino Septic
  - Housing Authority Septic
  - Residential Septic
  - 10-Year Contributing Area (Source Water Area)
- Land Use**
- Residential
  - Other Urban or Built-Up
  - Evergreen Forest
  - Forested Wetland
  - Water

Data for PWS wells #EPA5293303

Land use percentage, by type:

Residential	0.84%
Evergreen Forest Land	81.5%
Forested Wetland	16.0%
Lakes	1.70%

Total length of roads = 0.38 miles  
(Road density is very low)

Pumping rate = 9,600 gallons per day, five year average

**Information from USEPA BASINS program regarding Potential Contaminant Sources:**

Potential contaminant sources within the source water area (SWA):

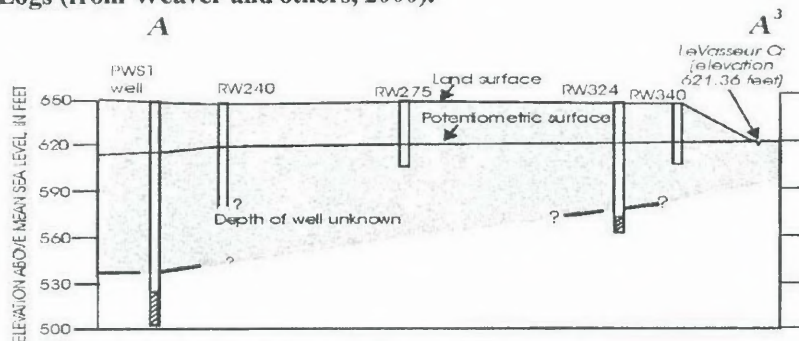
Permitted facilities:

None

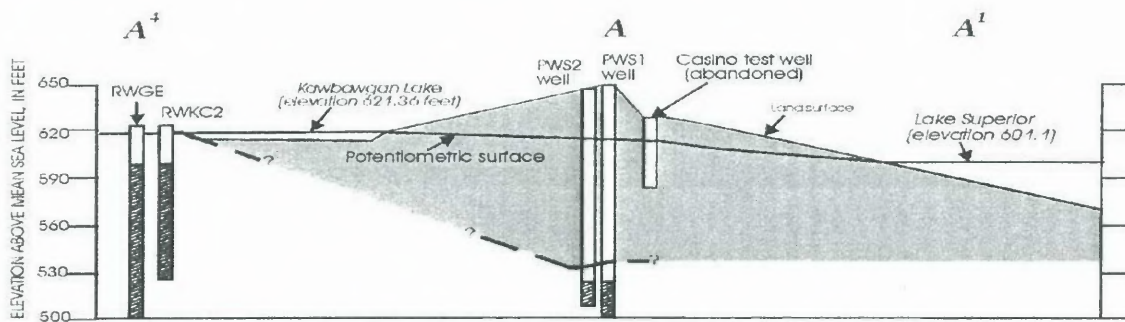
Point sources:

13 domestic septic systems  
1 commercial septic system

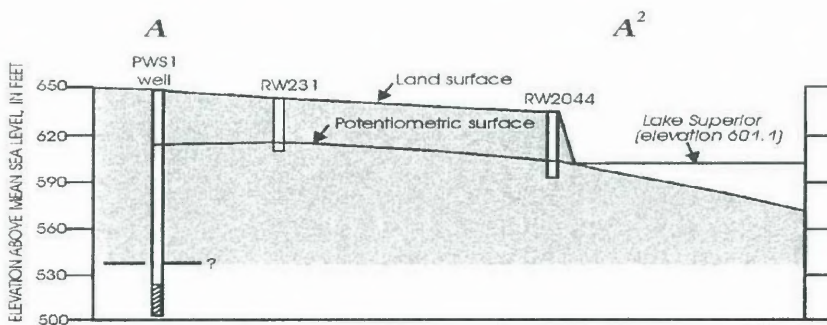
**Geologic Logs (from Weaver and others, 2000):**



**Figure 3. A-A<sup>3</sup>**






**Figure 4. Section A<sup>4</sup>-A<sup>1</sup>.**



**Figure 5. Section A-A<sup>2</sup>.**

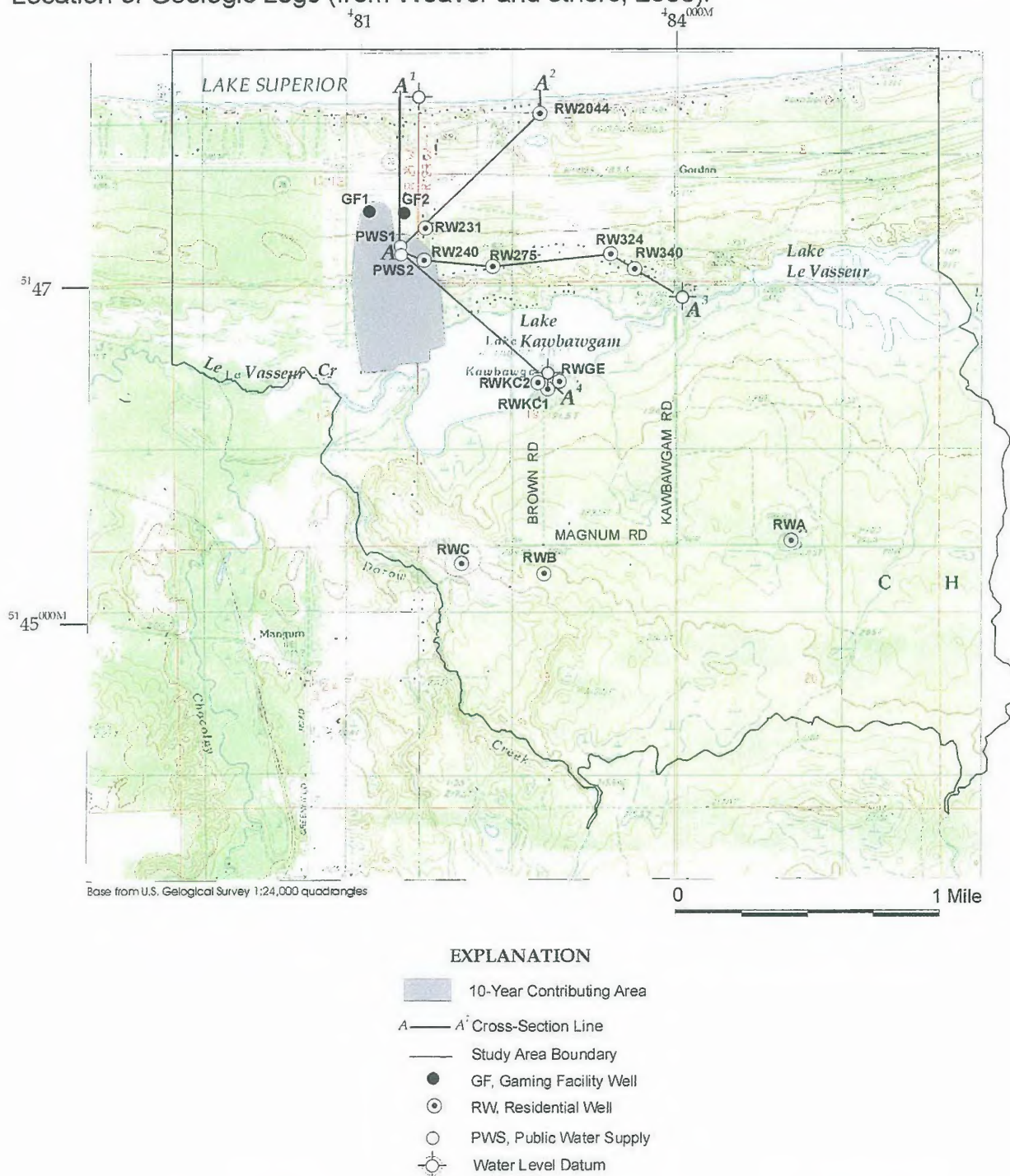
**EXPLANATION**

-  UNCONSOLIDATED GLACIAL AND LACUSTRINE SEDIMENTS
-  Borehole open to Jacobsville Sandstone Formation
-  CONTACT BETWEEN GLACIAL AND LACUSTRINE SEDIMENTS/  
JACOBVILLE SANDSTONE FORMATION—Dashed where  
approximately located. Queried where insufficient data available

*WELL RW324 is included to show geologic unit location only. Elevation of top of casing and depth to potentiometric surface is unknown*

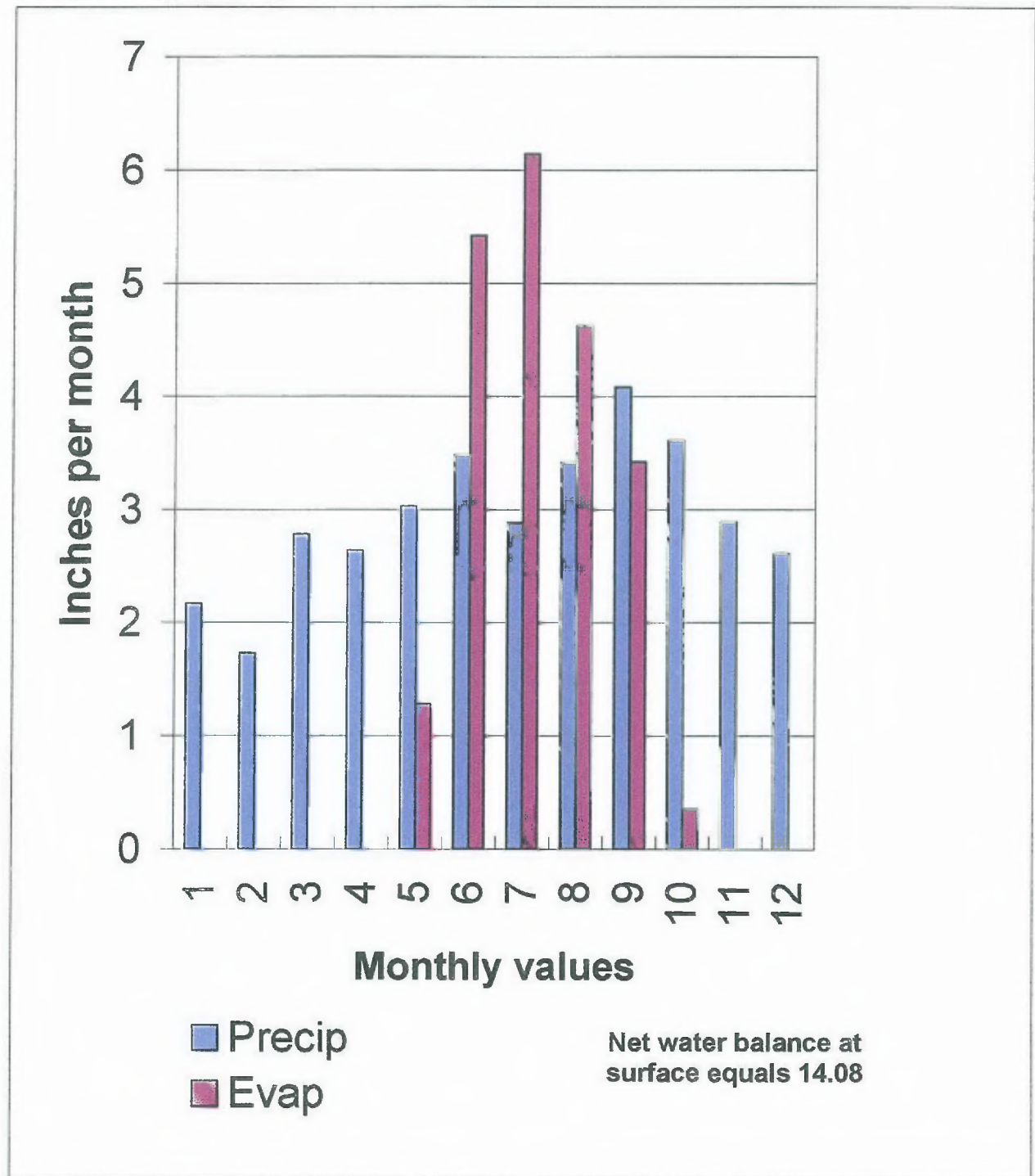
**Figure 3, 4, and 5.** Generalized hydrogeologic sections showing potentiometric surface and stratigraphic relations of Jacobsville Sandstone Formation and younger geologic units, Kawbawgam Lake area, Marquette County, Michigan. (Line of sections shown in figure 2.)

Location of Geologic Logs (from Weaver and others, 2000):

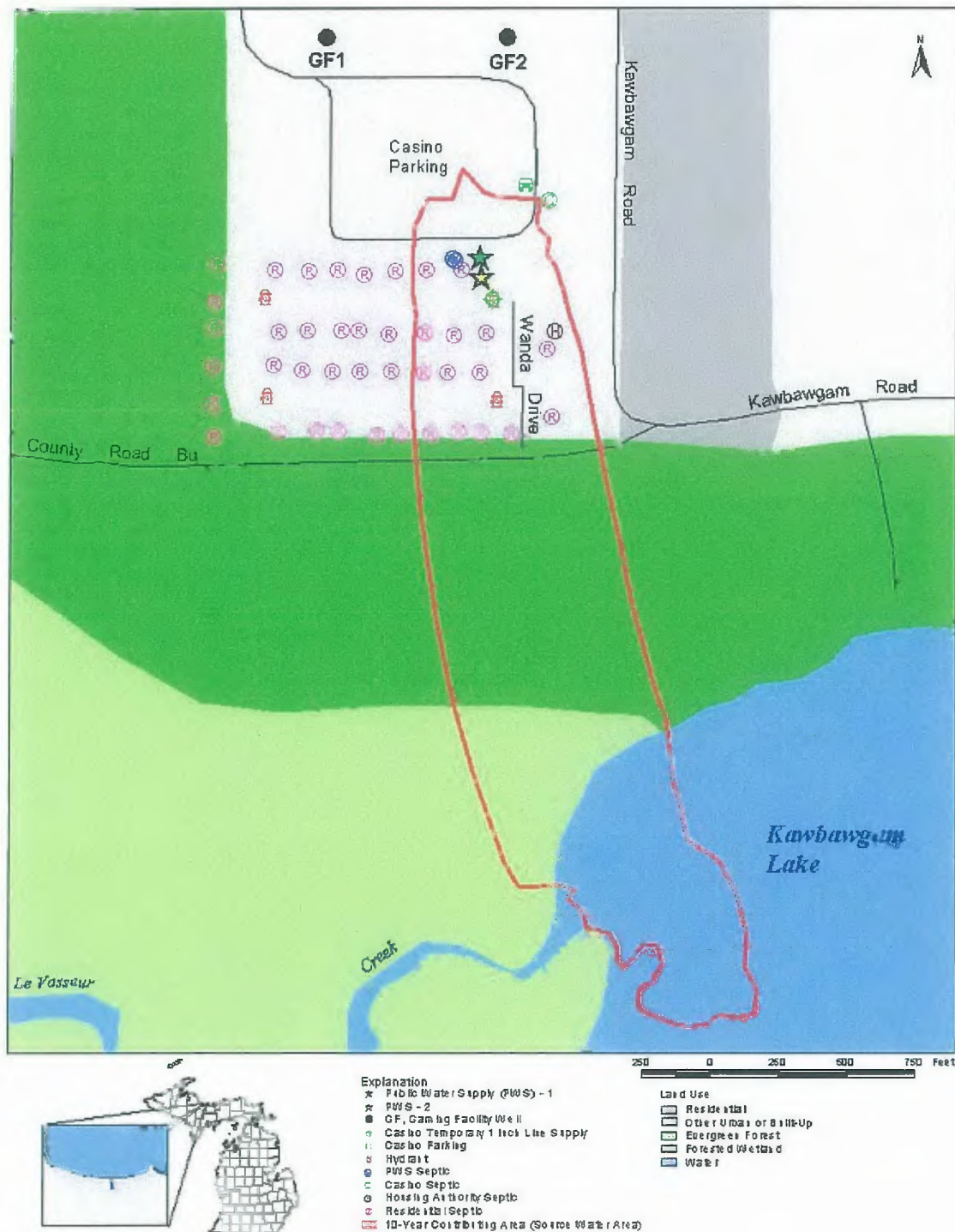


**Figure 2.** Modeled area plotted on USGS 1:24,000 quadrangle map showing 10-year contributing areas for public water-supply wells and gaming facility wells, Keweenaw Bay Indian Community study area.

**Precipitation and Evaporation Data:**



Delineated Ten-Year Capture Zone:



**History of Raw Water Quality at the Source:** Tribal water supplies are required to routinely monitor raw and treated water for a list of contaminants that is determined by USEPA and the Safe Drinking Water Act. A detection of any contaminant may indicate that a pathway exists for contaminants to reach the well. It is important to realize that the results from a given sample only provide information regarding the water quality at the time the sample was collected. Water quality can change with time for a number of reasons. The fact that a water sample does not contain contaminants is no guarantee that contamination will not occur in the future. Conversely, the detection of a contaminant in the past does not indicate that it will occur in the future. Review of water supply records indicates that in general, synthetic and volatile organic compounds are not present in the water, except for four synthetic organic compounds that are the result of the disinfection process. These four compounds are present in quantities ten to one thousand times smaller than the health limit set by the USEPA.

**Sensitivity Analysis:** Sensitivity is the natural ability of a SWA to provide protection against the contamination of the water supply well(s), and includes physical attributes of the materials in which the well(s) is located. The sensitivity analysis requires consideration of several different variables related to the natural environment, including: well construction; well depth; well age; geology of material in which the well is finished, and through which it passes; pumping rate; and water quality of the source (aquifer).

To perform this analysis, USGS and KBIC collected, researched, and analyzed information from operator reports, soil maps, published reports, historical plant operation data, and raw water quality data. The Kawbawgam wells were drilled in 1990 and 1991, are 145 and 138 ft deep, respectively, and are open to 20.5 and 15 feet of aquifer, respectively. The wells have high geological susceptibility because there is little clay or other fine material in the deposits overlying the aquifer.

**Susceptibility Determination:** Susceptibility is the relative potential for contamination to reach the water supply well(s) used for drinking water purposes. Whereas the sensitivity of a water supply is the natural ability of the area to protect the well(s) against contamination, the susceptibility determination also takes into account other factors that will affect whether a contaminant reaches the well(s). Whether or not a particular drinking water source becomes contaminated depends on three factors:

- (1) The distribution and proximity of potential contaminant sources (PCS) to the source-water area (SWA);
- (2) The geology of the SWA; and
- (3) The natural protection, or sensitivity, of the source.

In conducting a susceptibility determination, the part of the SWA that yields water to the well is identified – in this case by development of a model of ground water flow (Weaver and others, 2000). PCS within the SWA area are then located. Based on the distribution of PCS within the susceptible area, the type of PCS, and the nature of the chemicals they use or store, PCS are analyzed for the risk they may represent to the water supply well(s). Along with the presence and distribution of PCS, the sensitivity analysis is then used to determine the susceptibility of the water supply. This leads to a susceptibility determination for the water supply. It is important to understand that a system can have low susceptibility relative to some conditions (for example, well construction and location), and high susceptibility because of other conditions (for example, the type of PCS).

All water supplies, regardless of their susceptibility, should consider identified factors that could lead to higher susceptibility in the future, and should prepare a strategy to protect the water supply source. Raising public awareness through signs and other education programs, encouraging proper well construction and the use of best management practices in existing facilities are good ways of ensuring that a surface water source maintains its low susceptibility rating. The Kawbawgam supply wells have low susceptibility related to well construction, contaminant sources, and water quality. The overall susceptibility of the wells is low.

## References

- Weaver, T.L. Luukkonen, C.L., and Ellis, J.M., 2000, Simulation of ground-water flow and delineation of contributing area to public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 00-4050, 25 p., 4 appendixes.
- Rasanen, Carl. Water supply operator. Written communication, 23 August 2002.

Appendix 4

**Source Water Protection Program Contingency Plan  
Kawbawgam Road Housing Community Public  
Water Supply Wells, Keweenaw Bay Indian Community,  
Marquette County, Michigan**

U.S. DEPARTMENT OF THE INTERIOR  
U.S. GEOLOGICAL SURVEY

By T. L. Weaver

# **Source Water Protection Program Contingency Plan Kawbawgam Road Housing Community Public Water Supply Wells, Keweenaw Bay Indian Community, Marquette County, Michigan**

*By T.L. Weaver*

## **GENERAL INFORMATION**

The Keweenaw Bay Indian Community (KBIC) housing development on Kawbawgam Road is located in Marquette County, a few miles east of the City of Marquette.

Physical description of public water supply (PWS) wells: The Tribal housing community wells, PWS 1 and PWS 2, were drilled in 1990 and 1991, respectively. PWS 1 has a 6-inch diameter steel casing and is completed to a depth of 145 feet (ft) and PWS 2 has an 8-inch steel casing and is completed to a depth of 138 ft. PWS 1 is open to 20.5 ft of aquifer material (Jacobsville sandstone) and PWS 2 is open to 15 ft of aquifer material. Both wells are equipped with 100 gallon-per-minute (gpm) submersible pumps, but were set to pump at 50 to 53 gpm in 1999 (Carl Rasanen, KBIC, oral commun., 1999). Both wells feed into a single treatment area. Only one well is typically used at a time and the other well is kept on standby to satisfy firm capacity requirements.

## **SHORT-TERM EMERGENCY WATER SUPPLY OPTIONS**

1. Purchase bottled water and distribute to individual homes for potable uses only. It is possible that the PWS wells could be rendered unusable due to dermal and inhalation dangers depending on the nature of the contamination. Should the wells prove to be unusable for any purpose, one or more of the long-term solutions listed below will have to be used.
2. Water could be purchased from either Marquette or K.I. Sawyer PWS, since their systems would likely be unaffected by contamination or other problems that have caused the Kawbawgam Road PWS wells to become unusable. Water would have to be hauled in tank trucks and distributed in some manner to the Tribal housing community.
3. Supply Tribal housing community water system with water from the Gaming Facility. The gaming facility wells have typically provided poorer quality water than the PWS wells (Scott Helgeson, Indian Health Service, oral commun., 1999), with iron concentrations at least 4 times greater than typical from PWS wells. Water quality could be improved with a treatment regimen. It is likely that the Tribal housing community wells and gaming facility wells would be similarly impacted, given the fact that the delineated wellhead protection areas (WHPA) overlap.
4. Install treatment devices at the wellhead to remove contaminant. This may not be possible depending upon the nature of the contaminant. Treatment units may not be available or installed rapidly enough to alleviate immediate needs.

5. Combination of the above.

### **LONG-TERM ALTERNATIVE WATER SUPPLY OPTIONS**

Depending upon the type of contamination, or other problem related to the Kawbawgam Road PWS wells, and other related unknowns, possible long-term options are the following:

1. Construction/installation of a treatment facility at the wellhead that sufficiently removes contaminants.
2. Installation of filtering equipment at point-of-entry locations (i.e., on the taps).
3. Supply Tribal housing community water system with water from the Gaming Facility. The gaming facility wells have typically provided poorer quality water than the PWS, but could be improved with a treatment regimen. As noted in the short-term alternatives, these wells would likely be impacted by any contamination of the PWS wells given the overlap in zones of contribution.
4. Develop a new well field, either within Tribal property boundaries or off-site. It would be necessary to build a water-supply line from the new well field location to the existing treatment facility, or at the very least, to the Tribal housing complex. Cost would depend on development of the new well field, length of the water-supply line, and construction of a new treatment facility, or improving the current treatment facility.
5. Connection with community water supply at the City of Marquette if it is unaffected by the contamination present in the Kawbawgam Road PWS wells. This will be an expensive procedure given the need to transport water over some distance from the City of Marquette.
6. Development of a new surface water intake site, or public water supply wells. Installation of a surface water intake will probably require modifications or replacement of the current treatment plant, but may be cheaper than installing a water-supply line to a connection with the City of Marquette system.
7. Remediation of well field and aquifer. This is typically expensive and may not be completely successful.
8. Combination of the above.

### **EXISTING POTENTIAL CONTAMINANT SOURCES:**

There are several possible sources of contamination within the WHPA; point sources include septic systems for the 14 private residences, housing office, and the gaming facility, and the standby generator at the gaming facility. Non-point sources include lawn chemicals and the parking lot for the gaming facility, because of fuels and other fluids leaking from vehicles. Within the 10-year time of travel (WHPA) to the wells identified by the USGS (Weaver and others, 2000), there are no regulated facilities, or facilities with permits to store, handle, or discharge potential contaminants. The susceptibility of the source water to contamination is considered low.

There are a number of other ways that contaminants can affect source water for the Kawbawgam Road PWS wells. A brief and generalized summary of possible sources is listed below. The following is a detailed list of potential sources of contamination (naturally occurring, agricultural and commercial forestry, residential, municipal, commercial, and industrial sources and

processes), which will be updated/tabulated as time and resources are available. *Most of the list is inapplicable to the Kawbawgam Road PWS wells but should be considered carefully to avoid overlooking a source.* The master list of these updates will be a permanent part of the wellhead protection plan (WHPP).

<b>Naturally occurring sources</b>	<b>Potential contaminants</b>
Rocks and soils	e.g., metals, iron, arsenic, magnesium, sulfates, fluorides, etc.
Contaminated water	e.g., bacteria, salts, viruses
Decaying organic matter	Bacteria
Radioactive materials	e.g., mine tailings, radon gas
Natural geological processes	e.g., salt water infiltration of wells

<b>Agricultural/logging sources</b>	<b>Potential contaminants</b>
Animal feedlots, burial areas	e.g., livestock sewage wastes, chemical sprays/dips, viruses, coliform and non-coliform bacteria, nitrates
Crop areas, irrigation sites	e.g., pesticides, petroleum products
Chemical storage	e.g., pesticides, herbicides, fertilizers, petroleum products, solvents, paints, etc.
Farm/logging machinery	e.g., fuel, lubricants, hydraulic oil, solvents
Logging road stream crossing	e.g., sedimentation, petroleum products, etc.

<b>Residential sources</b>	<b>Potential contaminants</b>
Household chemicals	e.g., cleaners, bleach, paint and paint removers, strippers, petroleum products
Lawn and gardens	e.g., pesticides and herbicides, petroleum products
Swimming pools	Chemicals
Septic systems and sewage lines	e.g., sewage, bacteria, viruses, metals, petroleum products, anti-freeze, road salt, chemicals, etc.
Underground storage tanks	home heating oil
Apartments and condominiums	e.g., pool chemicals, pesticides, herbicides, household wastes

<b>Municipal sources</b>	<b>Potential contaminants</b>
Schools, Government buildings, and their grounds	e.g., pesticides, herbicides, solvents, petroleum products, general building wastes
Parks	e.g., pesticides, herbicides, petroleum products
Highways, roads	e.g., herbicides, road salt, petroleum products, etc.
Municipal sewage	e.g., sewage, sludge, treatment by-products, chemicals, bacteria, viruses
Storage, treatment, and disposal ponds and other surface impoundments	e.g., sewage, wastewater, liquid chemical wastes, bacteria, viruses
Sewer overflows	e.g., road runoff, bacteria, viruses
Recycling facilities	e.g., petroleum products, battery acid, anti-freeze, metals, etc.
Landfills	e.g., chemicals, petroleum products, solvents, etc.
Illegal dumps and open burning areas	e.g., chemicals, metals, petroleum products, metals, solvents, etc.
Municipal incinerators, burning areas	e.g., metals, chemicals, sulfur, etc.
Abandoned wells	e.g., petroleum products, etc.
Water supply wells	e.g., surface runoff, chemicals, etc.
Drainage wells	e.g., pesticides, herbicides, bacteria, etc.
Sumps and dry wells	e.g., storm run-off water, spilled liquids, dumped liquids, etc.
Artificial ground-water recharge	e.g., storm water runoff, excess irrigation water, treated sewage effluent that may contain detergents, solvents, etc.

<b>Commercial sources</b>	<b>Potential contaminants</b>
Airports and airfields	e.g., fuels, solvents, de-icers, wastes
Auto repair shops	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.
Barber and beauty shops	e.g., perm solutions, dyes, chemicals, etc.
Boat yards and marinas	e.g., fuels, lubricants, solvents, paints, wood preservatives, waxes, etc.
Bowling alleys	e.g., epoxy floor finishes, solvent, cleaning fluids
Automobile dealerships	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.
Car washes	e.g., soaps, detergents, petroleum products, anti-freeze, acids, road salt, etc.
Campgrounds	e.g., sewage, petroleum products, pesticides, household wastes
Carpet stores	e.g., glues and solvents, petroleum products
Cemeteries	e.g., chemicals, petroleum products, herbicides, etc.
Construction areas	e.g., solvents, asbestos, paints, glues, insulation, tars, sealants, chemicals, etc.
Dental facilities	e.g., discharge heavy metals into sanitary sewers
Dry cleaners	e.g., solvents, chemicals, etc.
Furniture refinishers	e.g., paints, stains, solvents
Gasoline dealers	e.g., petroleum products
Hardware and lumber stores	e.g., chemicals, stains, paints, petroleum products, etc.
Heating oil suppliers	e.g., petroleum products including stored materials
Horticultural practices	e.g., herbicides, pesticides, fungicides
Jewelry/metal plating	e.g., sodium and hydrogen cyanide, metallic salts, acids, chromium, etc.
Laundromats	e.g., detergents, bleaches, dyes
Medical institutions	e.g., X-ray developers/fixers, infectious wastes, disinfectants, radioactive wastes, pharmaceuticals, etc.
Office buildings	e.g., building wastes, lawn and garden maintenance chemicals, etc.
Paint stores	e.g., paints, stains, solvents, wood preservatives, etc.
<b>Commercial sources-continued</b>	<b>Potential contaminants</b>
Pharmacies	e.g., spilled and returned products
Photography shops and labs	e.g., silver sludge

Print shops	e.g., inks, solvents, photographic chemicals
Railroads	e.g., herbicides, petroleum products, chemicals, etc.
Research laboratories	e.g., X-ray fixers/ developers, infectious/radioactive wastes, disinfectants, pharmaceuticals
Scrap and junk yards	e.g., any wastes from businesses or households such as metals, chemicals, petroleum products, solvents, acids, anti-freeze, etc.
Storage tanks	e.g., any chemical in a storage tank
Transportation services	e.g., petroleum products, solvents, etc.
Veterinary services	e.g., solvents, infectious wastes, vaccines, disinfectants,

<b>Industrial sources</b>	<b>Potential contaminants</b>
Material stockpiles (coal, metallic ores)	e.g., acid drainage, metals runoff
Waste tailing ponds/basins	e.g., acids, metals, radioactive ores
Transport and transfer stations	e.g., fuel tanks, repair shop wastes, etc.
Storage tanks (above and below ground)	e.g., petroleum products
Storage, treatment, or disposal ponds & other surface impoundments	e.g., sewage wastewater, liquid chemical wastes, bacteria, viruses
Chemical landfills	e.g., hazardous and no-hazardous liquid wastes
Radioactive waste disposal sites	e.g., radioactive wastes from medical facilities, power plants, or defense operations
Dry wells	e.g., saline water
Injection wells	e.g., oil field brine, chemicals, wastes, etc.

<b>Industrial processes</b>	<b>Potential contaminants</b>
Asphalt plants	e.g., metals, chemicals, sulfur, etc.
Communication equipment manufacturers	e.g., acid wastes, metal sludge, etchants, cutting oils, plating wastes
Electronic equipment manufacturers	e.g., cyanides, solvents, acids, paints, PCBs, etchants
Foundries and metal fabricators	e.g., heavy metals, paint wastes, plating wastes, solvents, oils, etc.
Furniture and fixtures manufacturers	e.g., paints, stains, solvents, degreasers
Metal and metal-working shops	e.g., solvents, lubricants, degreasers, metals
Mining operations	e.g., mine spoils, tailings, stamp sands, acids, highly-mineralized water, etc.
Unsealed abandoned mines used for waste pits	e.g., metals, acids, minerals, sulfides, etc.
Paper mills	e.g., metals, acids, chlorine, etc.
Petroleum storage companies	e.g., petroleum products
Industrial pipelines	e.g., corrosive fluids, petroleum products, hydrocarbons, etc.
Photo processing labs	e.g., silver sludge, cyanides, chemicals, etc.
Plastics materials and synthetics producers	e.g., solvents, oils, cyanides, acids, formaldehyde
Publishers, printers, and allied industries	e.g., inks, solvents, dyes, photographic chemicals
Public utilities	e.g., PCB from transformers and capacitors, oils, solvents, metal plating solutions
Sawmills and planers	e.g., wood residue, treated wood preservatives, paints, glues
Stone, clay, and glass manufacturers	e.g., solvents, oils and grease, glazing materials, metal sludge
Welding shops	e.g., oxygen and acetylene, metals
Wood preserving facilities	e.g., wood preservative chemicals, creosote

## **ZONING REQUIREMENTS**

All existing zoning ordinances shall apply. As with many source water areas, much of the contributing area is regulated by a different entity than the Tribe. Because the WHPA is only 0.2 mi<sup>2</sup>, it seems likely KBIC can work cooperatively with residents in, or near, the WHPA, and Chocolay Township to assure that health and safety of the source water are considered prior to allowing a PCS into the WHPA. Chocolay Township is zoned, with each parcel assigned one of several different designations. The document describing zoning restrictions is called the Chocolay Township Zoning Ordinance, which is available at the Township Office in Harvey (Randy Yelle, Chocolay Township zoning, oral commun., 2003).

## **REFRESHER AND PUBLIC AWARENESS PROGRAM**

On a regular basis, KBIC Natural Resources Department personnel shall conduct a brief program making all members of the WHPP Group aware of the importance of the WHPP. News bulletins should be aired in local media reminding residents of the importance of being good citizens and watchmen of the source water area (SWA).

Refresher courses should address proper handling and disposal of all potentially hazardous materials found in the SWA.

Regular visits should be made to schools and other community functions to remind the public and create an awareness of the importance of ground-water quality to everyday activities in the surrounding communities utilizing ground water including the Kawbawgam Road housing development.

## **EMERGENCY PROCEDURES**

### **Notify Immediately:**

Water Department personnel at KBIC

Arlan Friisvall, Director (906) 353-6623 (ext. 4126)

Cell (906) 250-3221

Pager (906) 222-2214

Carl Rasenen, Kawbawgam Road water plant operator

(906) 353-7117

KBIC Natural Resources Department: (906) 524-5757

KBIC Tribal Police Department: (906) 353-6626, 524-6699

Marquette County Emergency Services Director: (906) 346-4045

Michigan Department of Environmental Quality, Remediation and Redevelopment Division; Clif Clark, District Supervisor, Upper Peninsula District, (906) 346-8515

U.S. Environmental Protection Agency: (KBIC) Marc Slis Tribal EPA contact (906) 524-5757, Ext. 15, (EPA) Chuck Pycha, Technical contact (312) 887-0259; Dennis Baker, Circuit Rider (231) 271-7492

### Emergency and short-term water supply options

Option	Technical and logistical feasibility	Reliability	Political considerations	Cost considerations
Bottled water	Easily obtainable	Good, Does not deal with dermal or inhalation exposure, which may still be present in non-potable use water	Good	Variable, price could be negotiated with suppliers
Tank Trucks	May be available from National Guard or private milk haulers. Milk haulers common given the presence of Jilbert's Dairy in Marquette	Tanks need to be sterile. Milk trucks typically back haul City water after unloading milk	Good	Variable, low capital investment
Conservation	Requires public education. Important to protect priority demand	Depends on voluntary compliance.	Generally positive, except for groups excluded by priority use restrictions. Does not supply all water demands	Low
Obtain water from Gaming Facility wells	Good. A connection between the two systems, or some other means of distributing water to Tribal members would have to be established	Poor to fair, water quality concerns with water from Gaming Facility wells, best solution would be install iron removal unit. Likely to also be contaminated if PWS wells are impacted	Fair, likely to impact availability of water to Gaming Facility	Moderate, depending
Treatment at wellhead	Not always an option. Treatment technologies may not be readily available, if at all	Contaminant specific	Public confidence in treated water	Variable, can be capital intensive

## Long-term water supply replacement options

Option	Technical and logistical feasibility	Reliability	Political considerations	Cost considerations
Additional treatment on current supply at the wellhead	Not always an option. Depends on nature of problem, contaminant, etc.	Contaminant specific	Public confidence in treated water	Variable, can be capital intensive
Point-of-use treatment	Variety of systems available. Installation may be problematic. May not be useable for specific contaminant	Good to poor. Inadequate performance is possible. <i>Not maintenance free</i> . Does not deal with dermal or inhalation exposure, which may still be present in non-potable use water	Potential conflict over who owns the filters and who does maintenance	Each unit has a fixed cost, plus maintenance cost
Develop new well field	May not be possible on Tribal property depending on extent of contamination at existing well field. May require purchase of off-site property and a connecting pipeline	Good	Public confidence in treated water	Relatively low to High, may require substantial investment in new property and water transmission facilities
Interconnection with another system	Will require approval by Marquette, K.I. Sawyer, or other community for connection. Requires many miles of pipe to nearest connection	Good	Will require Tribe to purchase water from a municipal source, loss of autonomy	High, capital intensive and may require increased rates to customers
Develop intake(s) in Lake Superior	May be difficult, depends on nature of problem at old intake. Will require at least a mile of pipe. Will also require substantial changes to current treatment facilities, although initial water quality is excellent	Good, although subject to security problems	May require acquisition of right of way. If system is developed with excess capacity, water could likely be sold to non-Tribal households around lake Kawbawgam and Gaming Facility since both have historically had poor water quality	High, capital intensive and may require increased rates to customers
Remediation	May not be possible, or may be too expensive in the current funding environment. Developing technology. Depends on degree of contamination	Contaminant specific	May require use of Federal or State Superfund or other clean-up monies	Very expensive in some instances. Can require a long-term commitment of funding and other resources

## Appendix 5

Process for completing the inventory of potential contaminant sources (PCS).

The process for completing the inventory included several steps, which are summarized as follows:

1. Reviewed readily available land use maps and historical/current aerial photographs.
2. Plotted relevant information from applicable state and federal regulatory databases including the following lists:
  - MDEQ leaking underground storage tank (LUST) sites.
  - MDEQ registered underground storage tank (UST) sites.
  - MDEQ Environmental Cleanup Site Information System (ECSI) sites; MDEQ Source Information System (for water discharge permit sites including National Pollutant Discharge Elimination System (NPDES) permits, Water Pollution Control Facility (WPCF) permits, storm water discharge permits, and on-site sewage (septic) system permits).
  - MDEQ Underground Injection Control (UIC) database.
  - MDEQ Active Solid Waste Disposal Permits list.
  - Michigan Department of Transportation (MDOT) - Hazardous Materials database.
  - State Fire Marshall registry of above-ground fuel storage tank sites.
  - State Fire Marshall Hazardous Material Handlers and Hazardous Material Incidents (HAZMAT) sites.
  - U.S. EPA BASINS software, version 2.1.
  - U.S. EPA Envirofacts database.
  - U.S. EPA Resource Conservation Recovery Act (RCRA) generators or notifiers list.
  - U.S. EPA RCRA Treatment, Storage, and Disposal Facility (TSDF) Permits list.
  - U.S. EPA National Priorities List (NPL).
  - U.S. EPA Comprehensive Environmental Response, Compensation and Liability Information System (CERCLA) List.
  - U.S. EPA RCRA Corrective Action Activity List (CORRACTS).
  - U.S. Department of Transportation (DOT) Hazardous Materials Information Reporting System (HMIRS).
  - U.S. EPA Toxic Chemical Release Inventory System (TRIS).
  - U.S. EPA Oil Pollution Act of 1990 Spill Response Atlas.
3. Met with public water supply and IHS officials by phone during September and October, 2001, to identify potential sources not listed elsewhere in databases or on maps, and completed a preliminary inventory form used to compile the SWA base map. Conducted subsequent contacts by email and telephone on numerous occasions to request additional data, clarify data, and discuss results.
4. Land use and/or ownership (for example, residential/municipal; commercial/industrial; agricultural/forest; and other land uses) was mapped and evaluated in relation to PCS,

soil characteristics, and proximity to the intake.

5. Completed final inventory form of PCS and plotted locations of PCS on the base map.

## **Appendix 6**

Tribal community ground-water supply, source water assessment worksheet (used for determining geologic sensitivity and susceptibility, Kawbawgam Road Housing Community public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan)

# Tribal Community Ground Water Supply Susceptibility Determination Worksheet

(fill out one worksheet for each CWS or each well if wells are screened in different  
aquifers or are not adjacent)

Name of Supply: Kawbawgam Road PWSID#: EPA5293303

Address: 103 Keweenaw Trail, Harvey, MI County: Marquette

Well No.(s): PWS1

Well Location(s): Chocolay Township

Well Log(s) Available	<u>Yes</u>	No
GPS Location Obtained for Well(s)	<u>Yes</u>	No

## Geologic Sensitivity - SWAS<sub>G</sub>

Geologic sensitivity is determined based upon the total thickness of Continuous Confining Material (CCM) or Continuous Partially Confining Material (CPCM). Beginning with a SWAS<sub>G</sub> of 30 points, 3 points are deducted for each 5 feet of CCM or 10 feet of CPCM. The CCM must be reported on the well record as 5 feet of continuous material and the CPCM 10 feet of continuous material to provide for a deduction. The summing of CCM layers thinner than 5 feet or CPCM layers thinner than 10 feet is not allowed. Where the point deduction exceeds 30 points, the SWAS<sub>G</sub> shall be assigned zero (0) points.

*CCM Table: Utilize where well log reports just Aclay≅or Ashale≅*

CCM (feet)	0 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 45	45 to 49	50 or greater	CCM Points.
Points.	0	3	6	9	12	15	18	21	24	27	30	N/A

*CPCM Table: Utilize where well log reports mixture of Aclay/sand≅or "shale/sandstone≅*

CPCM (feet)	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to 89	90 to 99	100 or greater	CPCM Points
Points	0	3	6	9	12	15	18	21	24	27	30	0

30 Points minus the sum of CCM points and the CPCM points - SWAS <sub>G</sub> (total must be greater-than-or-equal-to 0)	30
---	----

### Well Construction, Maintenance and Use - SWAS<sub>w</sub>

This portion of the source water assessment score provides an evaluation of the well(s) relative to the grouting, age, casing depth and pumping rate.

#### *Well Grouting*

Casing sealed from 10' above screen to surface with grout	Driven casing sealed entire length	Casing sealed from at least 25' BLS to surface	Casing not sealed or status unknown	Enter Points Below
0 pts.	5 pts.	10 pts.	15 pts.	5

#### *Well Age*

Constructed after 1994	Constructed 1976 - 1994	Constructed 1967 B 1976	Constructed Pre-1967	Enter Points Below
0 pts.	5 pts.	10 pts.	15 pts.	5

#### *Casing Depth*

Well cased 200 feet or greater	Well cased from 100 - 199 feet	Well cased from 25 - 99 feet	Well cased <25 feet or not known	Enter Points Below
0 pts.	5 pts.	10 pts.	15 pts.	5

#### *Pumping Rate*

100 gpm or less	101 - 500 gpm	501 B 1000 gpm	Greater than 1000 gpm	Enter Points Below
0 pts.	5 pts.	10 pts.	15 pts.	0

Sum of pts. from grouting, age, casing depth, and pumping rate - SWAS <sub>w</sub>	15
--	----

**Water Chemistry and Isotope Data - SWAS<sub>c</sub>**

This portion of the source water assessment score provides an evaluation of the well(s) relative to the presence of nitrates and nitrites, VOC's, SOC's, inorganic chemicals, radionuclides and tritium.

<b>Regulated Contaminants</b>	<b>Not Detected</b>	<b>Detected to &lt; 2 MCL</b>	<b>Detected 2MCL to MCL</b>	<b>Detected Exceeds MCL</b>	<b>Enter Points Below</b>
<i>Note sample date(s)</i>	0 points	10 points	20 points	50 points	
<b>Nitrates and Nitrites</b>	0				
<b>VOC=s</b>		10			
<b>SOC=s and Pesticides</b>		0			
<b>Inorganics except Fluoride</b>		10			
<b>Radionuclides</b>		10			

**Tritium Results**

No Test	Tritium @ < 1 TU	Tritium @ > 1 TU	Enter Points Below
0 pts.	-30 pts.	30 pts.	0

Sum of pts. from nitrate/nitrite, VOC's, SOC's and inorganic chemicals, radionuclides and tritium result (total must be greater-than-or-equal to zero) - SWAS <sub>c</sub>	30
--	----

### Isolation from Sources of Contamination - SWAS<sub>s</sub>

This portion of the source water assessment score provides an evaluation of the CPWS relative to the wells isolation from Amajor $\cong$  and Astandard $\cong$  sources of contamination. Sources of contamination are also evaluated dependent upon whether they are Apotential $\cong$  or Aknown $\cong$  sources of contamination.

#### *APotential $\cong$ Major Sources of Contamination from the 2 yr. TOT to the 5 yr. TOT*

Source of Contamination	Number of Sources	Distance From Well (feet)
Large Scale Waste Disposal	0	N/A
Land Application of Sanitary Wastewater or Sludge	0	N/A
Landfill	0	N/A
Bulk Chemical or Chemical Waste Storage Sites	0	N/A
Under Ground Storage Tank Sites	0	N/A
Other B Describe	0	N/A

Enter Points Below

Number of Major Sources from 2 yr. TOT to 5 yr. TOT	0	X 10	0
---	---	------	---

#### *APotential $\cong$ Major Sources of Contamination within 200 feet*

Number of Major Sources within 2 yr. TOT	0	X 20	0
--	---	------	---

#### *APotential $\cong$ Standard Sources of Contamination within the 2 yr. TOT*

Source of Contamination	Number of Sources	Distance From Well (feet)
Storm or Sanitary Sewers	0	N/A
Pipe Lines	0	N/A
Septic Tank or Septic Drain Field	2	80, 120
Cesspools, Seepage Pits or Dry Wells	0	N/A
Parking Lots / Roads	1	110
Surface Water	0	N/A
Other: Describe	0	N/A

Enter Points Below

Number of Standard Sources within 2 yr. TOT	3	x 10	30
---	---	------	----

*AKnown Sources of Contamination within the 5 yr. TOT*

Source of Contamination	Number Of Sources	Distance From Well (feet)
Act 201 Sites (formerly 307 sites)	0	N/A
Superfund Sites	0	N/A
Leaking Underground Storage Tank Sites	0	N/A

**Enter Points Below**

<b>Number of Known Sources within the 5 yr. TOT</b>	0	x 25	N/A
---	---	------	-----

*Control of Standard Isolation Area*

Own/Lease Entire Area	Own/Lease >1/2 Area	Own/Lease <1/2 Area	Enter Points Below
0 pts.	10 pts.	20 pts.	20

Sum of pts. From control and sources of contamination B SWAS <sub>s</sub>	50
---	----

**Source Water Assessment Score - SWAS**

Sum of SWAS <sub>G</sub> , SWAS <sub>w</sub> , SWAS <sub>C</sub> and SWAS <sub>s</sub> = SWAS	125
---	-----

SWAS<sub>G</sub>: High; SWAS<sub>w</sub>: Low; SWAS<sub>C</sub>: Low; SWAS<sub>s</sub>: Low; SWAS: LOW

Data Sources: 23 August 2002 meeting among Mike Donofrio, Kelly Jacobs, and Carl Rasanen, KBIC, and Mike Sweat, USGS; walk through of community and supply; CCR; water-quality laboratory reports; well logs; USGS report WRIR 00-4050; USGS GIS coverage including Federal, state, local, and miscellaneous contaminant source databases.

**Water Supply Contact:** Carl Rasanen

**Title:**

**Telephone No.** (906) 353 7117 Office, (906) 353 7623 Fax

Assessment Completed by: Mike Sweat, U.S. Geological Survey, Lansing, MI

Date: 5 September 2002

Comments: See attached maps for details of source-water assessment area. Refer to Weaver, T.L., Luukkonen, C.L., and Ellis, J.M., 2000, Simulation of ground-water flow and delineation of contributing area to public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 00-4050, 25 p., 4 appendixes, for details of delineation of contributing area.

# Tribal Community Ground Water Supply Susceptibility Determination Worksheet

(fill out one worksheet for each CWS or each well if wells are screened in different  
aquifers or are not adjacent)

Name of Supply: Kawbawgam Road PWSID#: EPA5293303

Address: 103 Keweenaw Trail, Harvey, MI County: Marquette

Well No.(s): PWS2

Well Location(s): Chocolay Township

Well Log(s) Available	<input checked="" type="radio"/> Yes	<input type="radio"/> No
GPS Location Obtained for Well(s)	<input checked="" type="radio"/> Yes	<input type="radio"/> No

## Geologic Sensitivity - SWAS<sub>G</sub>

Geologic sensitivity is determined based upon the total thickness of Continuous Confining Material (CCM) or Continuous Partially Confining Material (CPCM). Beginning with a SWAS<sub>G</sub> of 30 points, 3 points are deducted for each 5 feet of CCM or 10 feet of CPCM. The CCM must be reported on the well record as 5 feet of continuous material and the CPCM 10 feet of continuous material to provide for a deduction. The summing of CCM layers thinner than 5 feet or CPCM layers thinner than 10 feet is not allowed. Where the point deduction exceeds 30 points, the SWAS<sub>G</sub> shall be assigned zero (0) points.

*CCM Table: Utilize where well log reports just Aclay≅ or Ashale≅*

CCM (feet)	0 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 45	45 to 49	50 or greater	CCM Points.
Points.	0	3	6	9	12	15	18	21	24	27	30	N/A

*CPCM Table: Utilize where well log reports mixture of Aclay/sand≅ or "shale/sandstone≅*

CPCM (feet)	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to 89	90 to 99	100 or greater	CPCM Points
Points	0	3	6	9	12	15	18	21	24	27	30	6

30 Points minus the sum of CCM points and the CPCM points - SWAS <sub>G</sub> (total must be greater-than-or-equal-to 0)	24
---	----

### **Well Construction, Maintenance and Use - SWAS<sub>w</sub>**

This portion of the source water assessment score provides an evaluation of the well(s) relative to the grouting, age, casing depth and pumping rate.

#### ***Well Grouting***

<b>Casing sealed from 10' above screen to surface with grout</b>	<b>Driven casing sealed entire length</b>	<b>Casing sealed from at least 25' BLS to surface</b>	<b>Casing not sealed or status unknown</b>	<b>Enter Points Below</b>
0 pts.	5 pts.	10 pts.	15 pts.	5

#### ***Well Age***

<b>Constructed after 1994</b>	<b>Constructed 1976 - 1994</b>	<b>Constructed 1967 B 1976</b>	<b>Constructed Pre-1967</b>	<b>Enter Points Below</b>
0 pts.	5 pts.	10 pts.	15 pts.	5

#### ***Casing Depth***

<b>Well cased 200 feet or greater</b>	<b>Well cased from 100 - 199 feet</b>	<b>Well cased from 25 - 99 feet</b>	<b>Well cased &lt;25 feet or not known</b>	<b>Enter Points Below</b>
0 pts.	5 pts.	10 pts.	15 pts.	5

#### ***Pumping Rate***

<b>100 gpm or less</b>	<b>101 - 500 gpm</b>	<b>501 B 1000 gpm</b>	<b>Greater than 1000 gpm</b>	<b>Enter Points Below</b>
0 pts.	5 pts.	10 pts.	15 pts.	0

<b>Sum of pts. from grouting, age, casing depth, and pumping rate - SWAS<sub>w</sub></b>	<b>15</b>
--	-----------

**Water Chemistry and Isotope Data - SWAS<sub>c</sub>**

This portion of the source water assessment score provides an evaluation of the well(s) relative to the presence of nitrates and nitrites, VOC's, SOC's, inorganic chemicals, radionuclides and tritium.

<b>Regulated Contaminants</b>	<b>Not Detected</b>	<b>Detected to &lt; 2 MCL</b>	<b>Detected 2MCL to MCL</b>	<b>Detected Exceeds MCL</b>	<b>Enter Points Below</b>
<i>Note sample date(s)</i>	0 points	10 points	20 points	50 points	
<b>Nitrates and Nitrites</b>	0				
<b>VOC=s</b>		10			
<b>SOC=s and Pesticides</b>		0			
<b>Inorganics except Fluoride</b>		10			
<b>Radionuclides</b>		10			

*Tritium Results*

No Test	Tritium @ < 1 TU	Tritium @ > 1 TU	Enter Points Below
0 pts.	-30 pts.	30 pts.	0

Sum of pts. from nitrate/nitrite, VOC's, SOC's and inorganic chemicals, radionuclides and tritium result (total must be greater-than-or-equal to zero) - SWAS <sub>c</sub>	30
--	----

### Isolation from Sources of Contamination - SWAS<sub>s</sub>

This portion of the source water assessment score provides an evaluation of the CPWS relative to the wells isolation from A major $\equiv$  and A standard $\equiv$  sources of contamination. Sources of contamination are also evaluated dependent upon whether they are A potential $\equiv$  or A known $\equiv$  sources of contamination.

#### *A Potential $\equiv$ Major Sources of Contamination from the 2 yr. TOT to the 5 yr. TOT*

Source of Contamination	Number of Sources	Distance From Well (feet)
Large Scale Waste Disposal	0	N/A
Land Application of Sanitary Wastewater or Sludge	0	N/A
Landfill	0	N/A
Bulk Chemical or Chemical Waste Storage Sites	0	N/A
Under Ground Storage Tank Sites	0	N/A
Other B Describe	0	N/A

Enter Points Below

Number of Major Sources from 2 yr. TOT to 5 yr. TOT	0	X 10	0
---	---	------	---

#### *A Potential $\equiv$ Major Sources of Contamination within 200 feet*

Number of Major Sources within 2 yr. TOT	0	X 20	0
--	---	------	---

#### *A Potential $\equiv$ Standard Sources of Contamination within the 2 yr. TOT*

Source of Contamination	Number of Sources	Distance From Well (feet)
Storm or Sanitary Sewers	0	N/A
Pipe Lines	0	N/A
Septic Tank or Septic Drain Field	2	80, 120
Cesspools, Seepage Pits or Dry Wells	0	N/A
Parking Lots / Roads	1	110
Surface Water	0	N/A
Other: Describe	0	N/A

Enter Points Below

Number of Standard Sources within 2 yr. TOT	3	x 10	30
---	---	------	----

*AKnown Sources of Contamination within the 5 yr. TOT*

Source of Contamination	Number Of Sources	Distance From Well (feet)
Act 201 Sites (formerly 307 sites)	0	N/A
Superfund Sites	0	N/A
Leaking Underground Storage Tank Sites	0	N/A

Enter Points Below

Number of Known Sources within the 5 yr. TOT	0	x 25	N/A
--	---	------	-----

*Control of Standard Isolation Area*

Own/Lease Entire Area	Own/Lease >1/2 Area	Own/Lease <1/2 Area	Enter Points Below
0 pts.	10 pts.	20 pts.	20

Sum of pts. From control and sources of contamination B SWAS <sub>s</sub>	50
---	----

**Source Water Assessment Score - SWAS**

Sum of SWAS <sub>G</sub> , SWAS <sub>w</sub> , SWAS <sub>C</sub> and SWAS <sub>s</sub> = SWAS	119
---	-----

SWAS<sub>G</sub>: High; SWAS<sub>w</sub>: Low; SWAS<sub>C</sub>: Low; SWAS<sub>s</sub>: Low; SWAS: LOW

Data Sources: 23 August 2002 meeting among Mike Donofrio, Kelly Jacobs, and Carl Rasanen, KBIC, and Mike Sweat, USGS; walk through of community and supply; CCR; water-quality laboratory reports; well logs; USGS report WRIR 00-4050; USGS GIS coverage including Federal, state, local, and miscellaneous contaminant source databases.

**Water Supply Contact:** Carl Rasanen

**Title:**

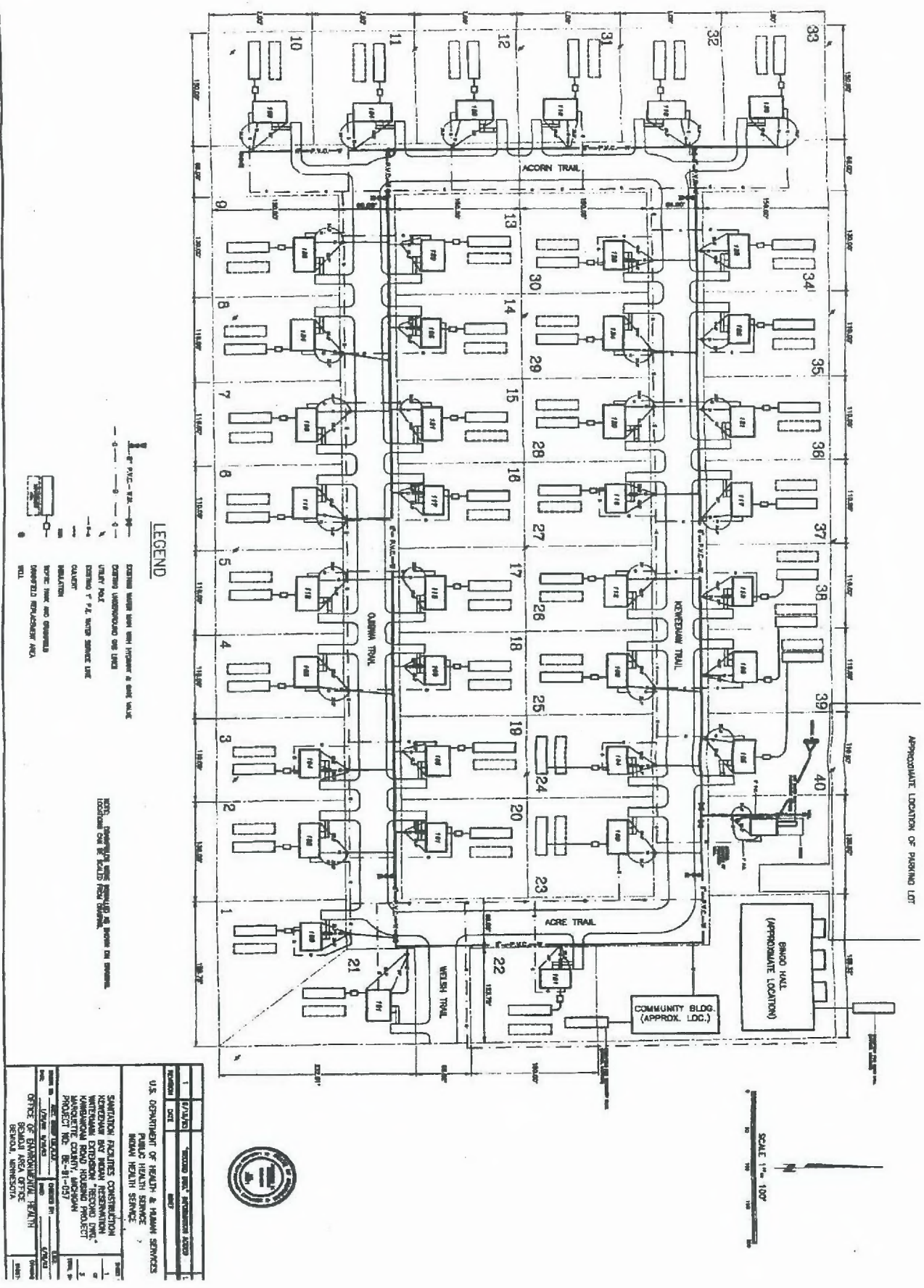
**Telephone No.** (906) 353 7117 Office, (906) 353 7623 Fax

**Assessment Completed by:** Mike Sweat, U.S. Geological Survey, Lansing, MI

**Date:** 5 September 2002

**Comments:** See attached maps for details of source-water assessment area. Refer to Weaver, T.L., Luukkonen, C.L., and Ellis, J.M., 2000, Simulation of ground-water flow and delineation of contributing area to public water supply wells, Keweenaw Bay Indian Community, Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 00-4050, 25 p., 4 appendixes, for details of delineation of contributing area.

**Appendix 6**  
Kawbawgam Rd. Septic Diagram

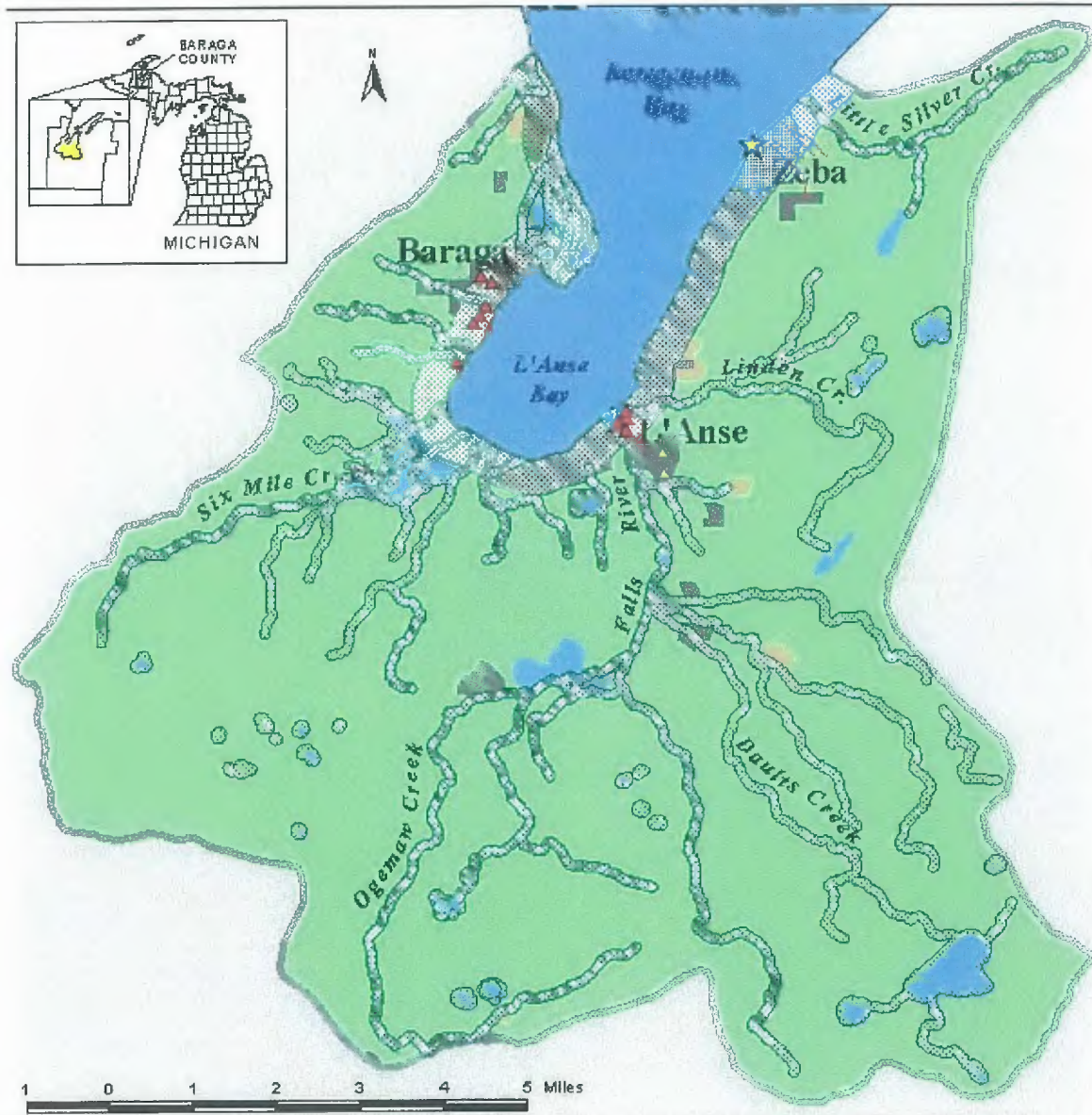




# Zeba Public Water Supply Source Water Assessment and Protection Plan

Keweenaw Bay Indian Community

By M.K. Slis and T. L. Weaver



## Table of Contents

INTRODUCTION TO SOURCE WATER PROTECTION OF SURFACE	
WATER SOURCES .....	1
<i>B.1 ASSESSMENT AND PUBLIC PARTICIPATION</i> .....	2
WORKSHEET 1 Public Participation .....	2
WORKSHEET 2 Management Group .....	2
WORKSHEET 3 Mission Statement .....	5
<i>B.2 DELINEATION</i> .....	7
WORKSHEET 4 (SWA) Delineation .....	7
WORKSHEET 5 (PWS) Location .....	7
<i>B.3 CONTAMINANT INVENTORY</i> .....	9
WORKSHEET 9 .....	9
WORKSHEET 12 ABANDONED WELL SURVEY .....	10
Zeba Watershed Inventory Summary of Results .....	11
WORKSHEET 13 Potential Contaminant Inventory: .....	12
WORKSHEET 13 Naturally Occurring Sources .....	12
WORKSHEET 13 Agricultural and logging sources .....	13
WORKSHEET 13 Residential sources .....	14
WORKSHEET 13 Municipal sources .....	15
WORKSHEET 13 Commercial Sources .....	16
WORKSHEET 13 Commercial Source Cont .....	17
WORKSHEET 13 Commercial Source Cont .....	18
WORKSHEET 13 Industrial Sources .....	19
WORKSHEET 13 Industrial Processes .....	20
WORKSHEET 13 Industrial Processes Cont .....	21
WORKSHEET 14 Permitted and Known Potential Contaminant Sources .....	22
<i>B.4 SUSCEPTIBILITY DETERMINATION</i> .....	24
Historical Contaminant Detections .....	24
<i>C.1 STRATEGIES FOR PROTECTING DRINKING WATER SOURCES</i> .....	25
Building a Source Water Assessment Protection Program .....	25
Non-regulatory Strategies .....	25
Regulatory Strategies .....	25
WORKSHEET 15 Evaluation of Management Strategies .....	26
WORKSHEET 16 .....	27
Selected References .....	28

# **Zeba Public Water Supply Source Water Assessment and Protection Plan**

*By M.K. Slis and T. L. Weaver*

## **INTRODUCTION TO SOURCE WATER PROTECTION OF SURFACE WATER SOURCES**

In 1996, Congress re-authorized the Safe Drinking Water Act. Legislation was added that gave the U.S. Environmental Protection Agency (USEPA) oversight over a process whereby source water assessments be performed on all sources of public drinking water. There have been several attempts to provide guidance documents for water suppliers with surface water sources. Needless to say, the complexity of protecting a surface water source is often, if not universally, more difficult than for a ground-water supply. Because of the complex nature of the task, no public water supplies (PWS) in Michigan using a surface water source had completed a source water assessment and protection plan (SWA&PP) at the time this document was being developed for the Zeba water supply of Keweenaw Bay Indian Community (January-February 2003).

An assessment protocol issued in June 2000 for Great Lakes sources was developed by a workgroup comprised of representatives from Great Lakes states, drinking water utilities, and USEPA Region 5 (appendix 1). In September 2001, the Michigan Section of the American Water Works Association and the Michigan Water Environment Association issued a joint position statement detailing their interpretation of source water protection (appendix 2). The assessment protocol was used to develop the Zeba source water assessment plan (SWA) (appendix 3) and the joint position statement was used to guide development of the SWA&PP. Minnesota Department of Health (MDH) is also in the developmental stages of producing a guidance document for the abundant surface water systems in that state. The draft version of the MDH document contains an excellent set of goals that summarize their drinking water priorities (appendix 4). These goals are typical of those of every surface water supplier in the Upper Midwest and are included because of their concise and representative quality. Excerpts from these documents are included in the appendixes, primarily to illustrate the framework on which the ZEBA SWAP and SWA&PP were developed.

A document entitled *Protecting Drinking Water: A Workbook for Tribes* (Totten, 2000) was used to provide an outline for the Zeba SWA&PP.

### **Protecting Drinking Water: An Example Workbook for Tribes**

KBIC and USGS chose *Protecting Drinking Water: A Workbook for Tribes*, written by Glenn Totten of the Water Education Foundation and funded by USEPA (version dated July 11, 2000; modified by USEPA Region 5 in November 2000) as a drinking water protection

guide. Language in this workbook is similar, if not identical in many sections, to previous documentation provided to Tribes by USEPA. This workbook contains 16 worksheets, which augment information previously gathered during the preparation of the SWA, and collectively form the basis for a SWA&PP that the USEPA is likely to approve. A great deal of information that is contained within the workbook should be updated as necessary to keep the SWA&PP as current as possible. Several worksheets were omitted from the Zeba SWA&PP because they were inapplicable.

## ***B.1 ASSESSMENT AND PUBLIC PARTICIPATION***

### **WORKSHEET 1 Public Participation**

Public participation is broken into 5 subcategories: forming a planning committee; adopting a mission, or mission statement; publicizing activities of the planning and advisory committees; drafting ordinances or codes; and notifying tribal members and leaders of the results of the SWA&PP processes. The first two items listed in the public participation part of worksheet 1 have been completed. The SWA has been made available to Tribal members and will be announced in the local papers for private citizen review, in October of 2003. Ordinances, regulations, or codes may follow public notification and would be noted within Worksheet 16, as updates to the plan. Delineation, contaminant inventory, and susceptibility determination are completed as part of SWA.

### **WORKSHEET 2 Management Group**

Worksheet 2 lists members of the team that oversees SWA&PP activities, contact information, and a brief description of how each member will be involved in the SWA&PP activities.

Active groups and/or individuals are listed in the first spreadsheet and secondary groups/individuals are listed in the second spreadsheet. Groups and individuals in the initial list are responsible for maintaining the SWA&PP, and will hereafter be referred to as the Group, while those on the second list play less important roles, such as initial compilation of the SWA&PP. Groups or individuals on the secondary list would be notified about problems with the SWA&PP, or within the source water area, if the initial Group determines that the secondary list groups or individuals need to play a role in efforts to address the problem. Members of the Group will institute provisions and make changes to the contingency plan, if necessary. A contingency plan has been produced as a separate document, complimenting the SWA&PP, and is included as appendix 5.

It should be noted that the majority of population of Baraga County is served by one of three surface water systems that draw from the source water area delineated in the Zeba SWA. Because of the common source water, it would be beneficial for water supply managers from L'Anse and Baraga to be active in the Zeba SWA&PP Group and vice versa.

**Management Group, charged with implementation and maintenance of Zeba SWA&PP**

<b>Groups to be represented</b>	<b>Name, position, and contact information</b>	<b>How will this person be involved?</b>
Program director	KBIC CEO 906-353-6623 (ext. 4104)	Coordinate Program; ensure that Tribal Groups use best management practices e.g. do not increase development pressure on the current delineated wellhead protection area.
Natural Resources Dept. Director	Mike Donofrio, KBIC Natural Resources Director 906-524-5757 (ext. 13)	Coordinate Program. Update WHPP.
Water Quality Specialist	Marc Slis, KBIC Water Quality Specialist 906-524-5757 (ext. 15)	
KBIC Environmental Specialist	Mike Sladewski, KBIC Environmental Specialist 906-5757 (ext. 14)	Maintain map of SWA/WHPA with updates to PCS list. Assist Group with developing ordinances and codes necessary to protect SWA.
KBIC, Tribal Police Department	Baraga (906) 353-6626 L'Anse (906) 524-6699	Uphold ordinances or codes adopted by KBIC and Group.
KBIC, Housing Authority	(906) 353-6623	Ensure that development activities pose no threat to Source Water Area, e.g., storm water and erosion runoff.
Baraga County Emergency Services Coordinator/Sheriff Department	Baraga County Emergency Preparedness Director (906) 524-7240	Uphold ordinances or codes adopted by Group. Notify Group or KBIC if emergency threatens source water.
Water Plant Operator, Zeba	Arlan Friisvall, Director (906) 353-6623 (ext. 4126) Cell (906) 250-3221 Pager (906) 222-2214	Adjust water treatment plant as necessary to counteract changes in source water quality.
Bureau of Indian Affairs	Jim Ruhl, Hydrologist 612-713-4400, Ext. 1068	Represent BIA as necessary. Update SWA&PP as necessary.
U.S. Dept. of Agriculture, NRCS	Bruce Peterson, District Conservationist (906) 353-8225 (ext 2)	Represent USDS-NRCS on soil-related issues as necessary. Update SWA&PP as necessary.

**Secondary group, consisting of non-essential contacts that have either participated in the development of the SWA&PP, or could be contacted for informational purposes.**

<b>Groups to be represented</b>	<b>Name, position, and contact information</b>	<b>How will this person be involved?</b>
U.S. Geological Survey	Tom Weaver, Hydrologist (906) 786-0714	Developed the SWA&PP in conjunction with KBIC Environmental Director and Staff.
Michigan Department of Environmental Quality, Remediation and Redevelopment Division	Clif Clark, District Supervisor, Upper Peninsula District, 906-346-8515 clarkcg@michigan.gov	Notify KBIC if emergency threatens source water.
Michigan Department of Environmental Quality, Water Division	Chuck Thomas, Geologist, 906-475-2048	MDEQ Water Division administers the Source Water Protection program for the state and provides oversight for non-Tribal community water supplies.
Mead-Westvaco	906-524-6513	Mead-Westvaco is a primary landholder within the Zeba PWS SWA. Communicate Mead-Westvaco position regarding land-use and management practices with SWA&PP group.
U.S. Coast Guard	Portage Station (Dollar Bay) (906) 482-1520 Marquette (906) 226-3312	Notify KBIC if shipping emergency threatens source water.
Western UP District Health Department	Barry Gibbons, Water System Specialist (906) 482-7382	Assist with dissemination of group findings to non-Tribal community members.
U.S. Environmental Protection Agency	Chuck Pycha, Tribal Technical Contact (312) 886-0259  Dennis Baker, Michigan Circuit Rider (231) 271-7492	Represent U.S. EPA as necessary, assist group with addendums to SWA&PP as a necessary, as well as assistance with Great Lakes spills, land-based discharges, updating potential contaminant sources list.
Bureau of Indian Affairs	Forester Jeff Kitchens 906-353-6692	Represent BIA as necessary. Update SWA&PP as necessary.
Indian Health Service	Sanitarian (Rhineland Office) (715) 365-5120	Represent IHS as necessary, monitor finished and source water quality at Zeba WTP as necessary. Update SWA&PP as necessary.
Water Plant Operator, L'Anse	Water Plant (906) 524-5880 Pumping Station (906) 524-7230	Adjust water treatment plant as necessary to counteract changes in source water quality.
Water Plant Operator, Baraga	(906) 353-6795 Home (906) 482-7235	Adjust water treatment plant as necessary to counteract changes in source water quality.

Secondary group, consisting of non-essential contacts that have either participated in the development of the SWA&PP, or could be contacted for informational purposes-- continued.

Groups to be represented	Name, position, and contact information	How will this person be involved?
Wastewater Treatment Plant Operator, L'Anse	Louis Dudo (906) 524-6906 Jim Venerable (906) 524-7536 Tom Stapleford (906) 524-6714 Mike Lofquist (906) 524-7519	Notify water plant operators of unscheduled/scheduled dumping of wastewater lagoons and any additional information that will be useful to water plant operators prior to discharge.
Wastewater Treatment Plant Operator, Baraga	Lift station, Bob Coen (906) 353-7439 Joe Treadeau (906) 353-7457	Notify water plant operators of unscheduled/scheduled dumping of wastewater lagoons and any additional information that will be useful to water plant operators prior to discharge.

### WORKSHEET 3 Mission Statement

This worksheet is used to set goals and includes a mission statement, as well as ideas on how to accomplish them.

The mission (primary goal) of the group is protection of the Source Water Area used by three municipal water systems (Zeba, L'Anse, and Baraga) supplying the majority of the population in Baraga County. Specifically, this SWA&PP is for the Zeba PWS, but L'Anse and Baraga may also develop SWA&PP for their respective water systems in the future. The group should function in a communicative, cooperative, and proactive environment as much as practicable, using best management practices, having an effective emergency response plan that group members know and understand, and maintaining and *updating the Source Water Assessment and Protection Plan(s) as needed to keep the document(s) current.*

We have increased the likelihood of the Group obtaining their mission/primary goal by breaking it down into a series of smaller, more easily achievable goals. This worksheet lists the Group's goals and ideas and the steps needed to accomplish them.

This is part of the SWA&PP process where community participation may be useful, but not until a mission statement is approved and understood by members of the SWA&PP work group.

A table of goals has been developed with at least the following minimum categories, although the list most likely will contain others, as time progresses. Additions to the list will be noted within Worksheet 16.

Goal	How does group accomplish goal
Survey All properties within SWA for Potential contaminant source (PCS)	Send a voluntary questionnaire to each property owner, detailing project goals and why it is important for them to complete the questionnaire as honestly and thoroughly as possible.
Reduce salt runoff into Keweenaw Bay	Work with local, County, and State Highway agencies to coordinate street sweeping/flushing activities so that salt runoff into Bay is minimized.
Regulate current and future development along Keweenaw Bay to reduce or eliminate harmful materials from entering Bay	Enact zoning ordinances for KBIC Zeba and Baraga communities and work with Village of Baraga to enact similar ordinances (Village of L'Anse and L'Anse Township are zoned).

## **B.2 DELINEATION**

### **WORKSHEET 4 (SWA) Delineation**

The entire watershed area contributing to the south end of Keweenaw Bay was delineated for the Zeba PWS. Justification for delineating the watershed in this manner is detailed in the SWA (appendix 3). Keweenaw Bay, and Lake Superior are large bodies of water with huge watersheds, and obviously some artificial boundary conditions were incorporated to create a manageable area for the SWA and SWA&PP.

### **WORKSHEET 5 (PWS) Location**

#### **Drinking Water Source**

Location: Village of Zeba, Michigan; Baraga County

Mailing Address: Zeba Water Plant Operator, 107 Beartown Road, Baraga, Michigan, 49946

Organization: Keweenaw Bay Indian Community

Name of source: Lake Superior (Keweenaw Bay)

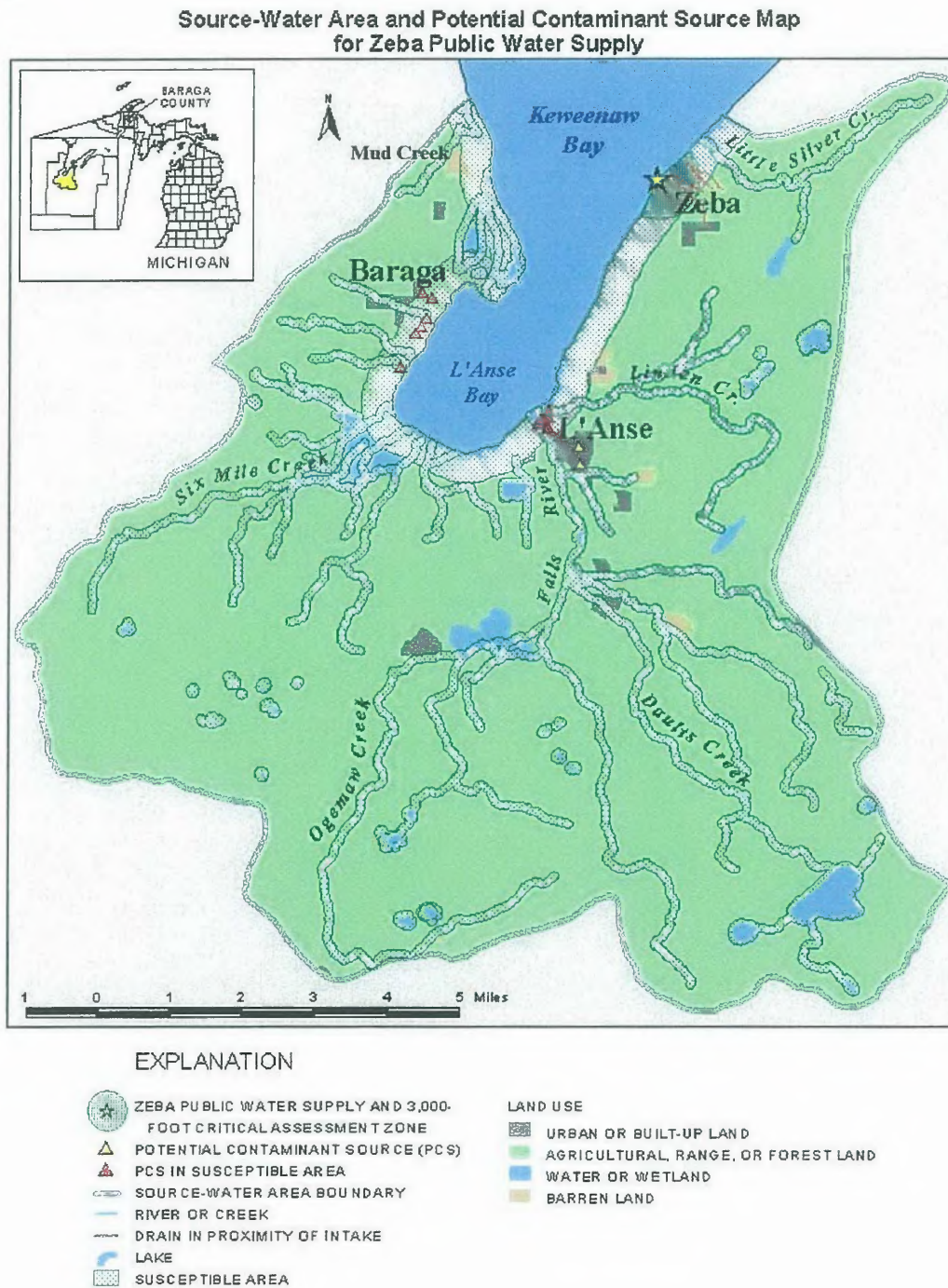
Location of intake: N46° 48' 23" W88° 25' 25"

Physical description of intake location: The Zeba water treatment plant and intake were completed in 1987. The intake consists of an 8 inch diameter ductile iron pipe extending 800 feet offshore. The intake terminates in 22 feet of water (based on 1927 datum), 4 feet above the bottom of Keweenaw Bay (Lake Superior).

### **WORKSHEET 7**

Requested information for Worksheet 7 was covered thoroughly in the SWA (appendix 3). The source water area is the entire watershed upstream of the intake, extending on the east side of Keweenaw Bay, northeast to the drainage basin boundary of Little Silver Creek (about 0.7 miles beyond the 3,000 foot Critical Assessment Zone), and on the west side of the Bay northwest to the drainage basin boundary of Mud Creek (figure 1.). The 98 mi<sup>2</sup> susceptible area includes the critical assessment zone as well as all the stream basins draining to Keweenaw Bay south of, and including, the Little Silver Creek on the east and Mud Creek on the west side of the Bay.

**Figure 1.** graphically illustrates potential contaminant sources within the source water area of the Zeba PWS. The entire drainage basin identified as the source water area is shown, with symbols and codes for a number of different layers including critical assessment zone, potential contaminant sources (PCS), susceptible area, land-use, and streams, lakes, and drains.



## ***B.3 CONTAMINANT INVENTORY***

### **WORKSHEET 9**

#### **RECORDS REVIEW FOR CONTAMINANT INVENTORY**

##### **Contaminant Source Inventory**

Past, current, and potential future sources of contaminants were inventoried to identify several categories of contaminants including microorganisms (bacteria, oocysts, and viruses), inorganic compounds (nitrates and metals), organic compounds (solvents, petroleum compounds, pesticides), and disinfection by-product precursors (trihalomethanes, haloacetic acids).

It is important to remember that sites and areas identified by this process are only **potential contaminant sources** (PCS) to the drinking water. Environmental contamination is not likely to occur when potential contaminants are used and managed properly. In addition, assumptions were made about particular types of land uses and risks associated with those land uses. Assumptions are discussed further in the results portion of this report.

The purpose of the inventory is three fold: 1) provide information on the location of PCS, especially those within the susceptible area; 2) to provide an effective means of educating the public about PCS; and 3) to provide a reliable basis for developing a management plan to reduce potential contaminant risks to the Zeba water supply.

The inventory process attempts to identify potential point-source contaminants within the SWA. It does not include an attempt to identify specific potential contamination problems at specific sites, such as facilities that do not safely store potentially hazardous materials. However, assumptions were made about particular types of land use. For example, it is assumed that rural residences associated with farming operations have specific potential contamination sources such as fuel storage, chemical storage and mixing areas, and machinery repair shops. It should also be noted that although the inventory depicts existing land uses, these are likely to undergo continual change due to normal crop rotation practices. What is irrigated farmland now may be non-irrigated farmland next year, or vice versa. Similar changes in commercial forests prevalent in the Upper Peninsula are also common. Areas harvested at the perceived maturity of the trees and re-planted as part of the process.

The results of the inventory were analyzed in terms of current, past, and future land uses and their relation to the susceptible area and the supply intake. In general, land uses and PCS that are closest to the supply intake and tributaries to the source water pose the greatest threat to a safe drinking water supply. Inventory results are summarized in the SWA, tables 1 and 2, and are shown on figure 5.

### Potential contaminant sources in the Zeba source water area

Type of potential contaminant source	Number of potential contaminant sources in the Source Water Area	Number of potential contaminant sources in the susceptible area
Hazardous or Solid Waste Site	11	9
Industrial Facilities Discharge Site	4	1
National Priority List Sites	0	0
Permit Compliance System	4	1
Toxic Release Inventory	1	1

## WORKSHEET 12 ABANDONED WELL SURVEY

### ABANDONED WELL SURVEY

Zeba water system uses surface water exclusively. At the present time, resources will not be used to survey for abandoned wells for the entire SWA. KBIC has conducted an inventory for the Little Silver Creek watershed that requested property owners to list abandoned wells on their property, as well as testing a number of water quality parameters. The responses were voluntary and it is possible that some owners are unaware of abandoned wells on their property. The results of the inventory are included in the following table summarizing the results. Out of a total of 35 addresses surveyed within the Zeba watershed, there were 7 abandoned well locations listed, of which 4 have not been properly abandoned. KBIC also conducted a similar survey in the Herman area and found 2 locations that had abandoned wells but both landowners listed the wells as properly abandoned.

A summary of the findings of the Zeba watershed inventory is attached. The database for the inventory is more complex, with additional categories, and includes identification numbers for each site. This information, particularly the addresses/locations of the wells should be included in the attached table or kept accessible for future reference.

Additional abandoned well information could be included in the SWA&PP at a later date and the following table is included for that purpose. It is possible that KBIC will complete more Integrated Resource Management Plan (IRMP) watershed surveys in the future and this database will be updated as those surveys are completed and as database management time is allocated.

## Zeba Watershed Inventory Summary of Results

Total number of homes surveyed: 35

<b>Alkalinity</b>	
Percent between 100-200 (indicating stable pH)	80.6
Percent <10 (indicating poorly buffered)	0
<b>Total Coliform</b>	
Number of Positive	4
Percent positive	11.1
<b>Conductivity</b>	
min	119
max	677
ave	250
median	249
<b>Copper</b>	
% violating primary or secondary drinking water standards	0
min	ND
max	140
mean	21.5
median	10.6
<b>Hardness</b>	
min	10.8
max	190
ave	87
median	100
% soft water	38.9
% moderately hard	27.9
% hard	25
% very hard	2.78
<b>Hydrogen Sulfide</b>	
min	ND
max	0.13
ave	0.02

<b>Magnesium</b>	
min	0
max	17.3
ave	4.73
median	3.69
<b>Manganese</b>	
% violating secondary drinking water standards	0
min	0.0029
max	0.3
ave	0.059
median	0.02
<b>Ammonia</b>	
min	ND
max	0.04
ave	0.025
median	0.025
<b>Nitrate</b>	
% violating primary drinking water standards	0
min	0
max	5.65
ave	1.01
median	0.735
<b>Zinc</b>	
% violating secondary drinking water standards	2.8
min	0
max	13000
ave	464
median	0.07
<b>pH</b>	
% alkaline and potentially caustic according to secondary drinking water standards	20

## Zeba Watershed Inventory Summary of Results

median	0.01
% detected the presence of HS-	28.6
<b>Iron</b>	
% violating secondary drinking water standards	2.8
min	ND
max	0.66
ave	0.11
median	0.054
<b>Lead</b>	
% violating primary drinking water standards	38.1
min	ND
max	2.4
ave	1.28
median	1.2

% acidic and potentially caustic according to secondary drinking water standards	2.8
ave	8.17
median	8.2
min	6.2
max	9.2
<b>Significant Survey Results</b>	
% isolation distance not compliant with current MI standards	8.5
% homes treating their own drinking water	20
Number of Abandoned Wells	7
Number of wells that have been properly abandoned	4
Number of UST discovered	0

## WORKSHEET 13 Potential Contaminant Inventory:

### WORKSHEET 13 Naturally Occurring Sources

#### CONTAMINANT INVENTORY CHECKLIST

The workbook has listed a number of potential sources of contamination (naturally occurring, agricultural (to which commercial forestry was added), residential, municipal, commercial, industrial, and industrial processes). These are a standard list and several of the non-applicable categories were removed. Additionally, several non-listed categories were added. Each table will have additional categories appended as necessary.

#### CONTAMINANT INVENTORY CHECKLIST

Check if present	Naturally occurring sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
YES	Rocks and soils	e.g., metals, iron, arsenic, magnesium, sulfates, fluorides, etc.	Iron in unconsolidated deposits and Jacobsville Sandstone aquifer	Entire source water area
YES	Decaying organic matter	e.g., bacteria		Varied, wetlands
POSSIBLE	Radioactive materials	e.g., radon gas	Present in unconsolidated deposits and Jacobsville Sandstone aquifer elsewhere in U.P.	Entire source water area
YES	Natural geological processes	e.g., salt water infiltration of wells	Present in Jacobsville Sandstone aquifer elsewhere in U.P.	Entire source water area

### WORKSHEET 13 Agricultural and logging sources

#### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Agricultural and logging sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
YES	Crop areas, forest irrigation sites	e.g., pesticides, petroleum products	crop areas	varied
YES	Chemical storage	e.g., pesticides, herbicides, fertilizers, petroleum products, solvents, paints, etc.	farms	varied
YES	Farm/logging machinery	e.g., fuel, lubricants, hydraulic oil, solvents	farms and logging operations	varied
YES	Public and logging road stream crossing	e.g., sedimentation, petroleum products, etc.		varied

## WORKSHEET 13 Residential sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Residential sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
YES	Household chemicals	e.g., cleaners, bleach, paint and paint removers, strippers, petroleum products	all residential locations	Varies
YES	Lawn and gardens	e.g., pesticides and herbicides, petroleum products	some residential locations	Varies
YES	Swimming pools	chemicals	some residential locations	Varies
YES	Septic systems and sewage lines	e.g., sewage, bacteria, viruses, metals, petroleum products, anti-freeze, road salt, chemicals, etc.	some residential locations	Varies
YES	Underground storage tanks	home heating oil	some residential locations	Varies

## WORKSHEET 13 Municipal sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Municipal sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
YES	Parks	e.g., pesticides, herbicides, petroleum products	L'Anse Park	~ 4 mi.
YES	Highways, roads	e.g., herbicides, road salt, petroleum products, etc.	Roads	Varies
YES	Municipal sewage	e.g., sewage, sludge, treatment by-products, chemicals, bacteria, viruses	L'Anse sewage plant	~ 4 mi.
YES	Storage, treatment, and disposal ponds and other surface impoundments	e.g., sewage, wastewater, liquid chemical wastes, bacteria, viruses	L'Anse sewage plant	~ 4 mi.
YES	Sewer overflows	e.g., road runoff, bacteria, viruses	L'Anse sewage plant/roads	Varies
NO	Recycling facilities	e.g., petroleum products, battery acid, anti-freeze, metals, etc.,		
POSSIBLE	Landfills	e.g., chemicals, petroleum products, solvents, etc.	Celotex landfill?/ Sprinkler area?	~ 8 mi.
YES	Illegal dumps and open burning areas	e.g., chemicals, metals, petroleum products, metals, solvents, etc.		Varied
NO	Municipal incinerators, burning areas	e.g., metals, chemicals, sulfur, etc.		
NO	Abandoned wells	e.g., petroleum products, etc.		
NO	Water supply wells	e.g., surface runoff, chemicals, etc		
NO	Drainage wells	e.g., pesticides, herbicides, bacteria, etc.		
NO	Sumps and dry wells	e.g., storm run-off water, spilled liquids, dumped liquids, etc.		
YES	Artificial ground-water recharge	e.g., storm water runoff, treated sewage effluent that may contain detergents, solvents, etc.		Varies

# WORKSHEET 13 Commercial Sources

## CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Commercial sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
NO	Airports and airfields	e.g., fuels, solvents, de-icers, wastes		
YES	Auto repair shops	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.	Range Auto, Thomas Ford, Kissel Chevy	~ 4-6 mi.
YES	Barber and beauty shops	e.g., perm solutions, dyes, chemicals, etc.	Varies, in L'Anse	~ 4-5 miles
YES	Boat yards and marinas	e.g., fuels, lubricants, solvents, paints, wood preservatives, waxes, etc.	L'Anse and Pequaming	~ 2, 4-5 mi.
YES	Bowling alleys	e.g., epoxy floor finishes, solvent, cleaning fluids	Whirli-Gig	< 1 mi.
YES	Automobile dealerships	e.g., petroleum wastes, solvents, anti-freeze, acids, etc.	Range Auto, Thomas Ford, Kissel Chevy	~ 4-6 mi.
YES	Car washes	e.g., soaps, detergents, petroleum products, anti-freeze, acids, road salt, etc.	L'Anse	~ 6 mi.
YES	Campgrounds	e.g., sewage, petroleum products, pesticides, household wastes	L'Anse Campground	~ 2 mi.
YES	Carpet stores	e.g., glues and solvents, petroleum products	L'Anse	~ 5 mi.
YES	Cemeteries	e.g., chemicals, petroleum products, herbicides, etc.	Indian Cemetery	~ 3-4 mi.
YES	Commercial fishing	e.g., nets set too close to intake could allow bacteria to enter source water	Keweenaw Bay	Varies
YES	Construction areas	e.g., solvents, asbestos, paints, glues, insulation, tars, sealants, chemicals, etc.	Various	Varies
YES	Dental facilities	e.g., discharge of heavy metals into sanitary sewers	L'Anse Dental	~ 4-5 mi.

# WORKSHEET 13 Commercial Source Cont.

## CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Commercial sources-continued	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
NO	Dry cleaners	e.g., solvents, chemicals, etc.		
NO	Furniture refinishers	e.g., paints, stains, solvents		
YES	Gasoline dealers	e.g., petroleum products	L'Anse	~ 5 mi.
YES	Hardware and lumber stores	e.g., chemicals, stains, paints, petroleum products, etc.	L'Anse	~ 6 mi.
NO	Heating oil suppliers	e.g., petroleum products including stored materials		
YES	Horticultural practices	e.g., herbicides, pesticides, fungicides	Golf course	~ 8 mi.
NO	Jewelry/metal plating	e.g., sodium and hydrogen cyanide, metallic salts, acids, chromium, etc.		
YES	Laundromats	e.g., detergents, bleaches, dyes	L'Anse	~ 5 mi.
YES	Medical institutions	e.g., X-ray developers/fixers, infectious wastes, disinfectants, radioactive wastes, pharmaceuticals, etc.	L'Anse	~ 4 mi.
YES	Office buildings	e.g., building wastes, lawn and garden maintenance chemicals, etc.	L'Anse	~ 4 mi.
YES	Paint stores	e.g., paints, stains, solvents, wood preservatives, etc.	L'Anse	~ 4 mi.
YES	Pharmacies	e.g., spilled and returned products	L'Anse	~ 4 mi.
YES	Photography labs	e.g., silver sludges	L'Anse	~ 4 mi.
YES	Print shops	e.g., inks, solvents, photo chemicals	L'Anse	~ 4 mi.
YES	Railroads	e.g., herbicides, petroleum products, chemicals, etc.	L'Anse/Baraga	~ 6 mi.
YES	Research laboratories	e.g., X-ray fixers/developers, infectious/radioactive wastes, disinfectants, pharmaceuticals	Hospital	~ 2 mi.

**WORKSHEET 13 Commercial Source Cont.****CONTAMINANT INVENTORY CHECKLIST-continued**

<b>Check if present</b>	<b>Commercial sources-continued</b>	<b>Potential contaminants</b>	<b>Potential contaminant source(s)</b>	<b>Distance from Zeba Water Intake</b>
YES	Scrap and junk yards	e.g., wastes such as metals, chemicals, petroleum products, solvents, acids, anti-freeze, etc.	Tasco?	~ 6 mi.
YES	Storage tanks	e.g., any chemical in a storage tank( <b>chlorine</b> )	Zeba PWS plant	Present at site
YES	Transportation services	e.g., petroleum products, solvents, etc.	L'Anse	~ 4-5 mi.
NO	Veterinary services	e.g., solvents, infectious wastes, vaccines, disinfectants		

## WORKSHEET 13 Industrial Sources

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Industrial sources	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
Possible	Material stockpiles (coal, metallic ores)	e.g., acid drainage, metals runoff	L'Anse	~ 5 mi.
NO	Waste tailing ponds/basins	e.g., acids, metals, radioactive ores		
NO	Transport and transfer stations	e.g., fuel tanks, repair shop wastes, etc.		
YES	Storage tanks (above and below ground)	e.g., petroleum products	Bill's Corner by hospital	~ 3 mi.
YES	Storage, treatment, or disposal ponds & other surface impoundments	e.g., sewage wastewater, liquid chemical wastes, bacteria, viruses	Various	Varies
NO	Chemical landfills	e.g., hazardous and no-hazardous liquid wastes		
NO	Radioactive waste disposal sites	e.g., radioactive wastes from medical facilities, power plants, or defense operations		
NO	Dry wells	e.g., saline water		
NO	Injection wells	e.g., oil field brine, chemicals, wastes, etc.		

## WORKSHEET 13 Industrial Processes

### CONTAMINANT INVENTORY CHECKLIST-continued

Check if present	Industrial processes	Potential contaminants	Potential contaminant source(s)	Distance from Zeba Water Intake
NO	Asphalt plants	e.g., metals, chemicals, sulfur, etc.		
NO	Communication equipment manufacturers	e.g., acid wastes, metal sludges, etchants, cutting oils, plating wastes		
NO	Electronic equipment manufacturers	e.g., cyanides, solvents, acids, paints, PCBs, etchants		
NO	Foundries and metal fabricators	e.g., heavy metals, paint wastes, plating wastes, solvents, oils, etc.		
NO	Furniture and fixtures manufacturers	e.g., paints, stains, solvents, degreasers		
YES	Metal and metal-working shops	e.g., solvents, lubricants, degreasers, metals	Johnson & Berry Mnf.	~ 5 Mi.
NO	Mining operations	e.g., mine spoils, tailings, stamp sands, acids, highly-mineralized water, etc.		
NO	Unsealed abandoned mines used for waste pits	e.g., metals, acids, minerals, sulfides, etc.		
NO	Paper mills	e.g., metals, acids, chlorine, etc.		
NO	Petroleum storage companies	e.g., petroleum products		
YES	Industrial pipelines	e.g., corrosive fluids, petroleum products, hydrocarbons, etc.	Celotex? Sprinkler field	~ 5-6 mi.
NO	Photo processing labs	e.g., silver sludges, cyanides, chemicals, etc.		
NO	Plastics materials and synthetics producers	e.g., solvents, oils, cyanides, acids, formaldehyde		
NO	Publishers, printers, and allied industries	e.g., inks, solvents, dyes, photographic chemicals		

**WORKSHEET 13 Industrial Processes Cont.****CONTAMINANT INVENTORY CHECKLIST-continued**

<b>Check if present</b>	<b>Industrial processes-continued</b>	<b>Potential contaminants</b>	<b>Potential contaminant source(s)</b>	<b>Distance from Zeba Water Intake</b>
YES	Public utilities	e.g., PCB from transformers and capacitors, oils, solvents, metal plating solutions	L'Anse Power plant	~ 5 mi.
YES	Sawmills and planers	e.g., wood residue, treated wood preservatives, paints, glues	Erickson Lumber	~ 6 mi.
NO	Stone, clay, and glass manufacturers	e.g., solvents, oils and grease, glazing materials, metal sludges		
NO	Welding shops	e.g., oxygen and acetylene, metals		
NO	Wood preserving facilities	e.g., wood preservative chemicals, creosote		

## WORKSHEET 14 Permitted and Known Potential Contaminant Sources

The list of PCS in the SWA (appendix 3) was complete with *all known permitted* sites within the source water area (SWA) and is also listed below. It is *not* anticipated that additional permitted PCS will be found within the SWA, although contaminant sources without permits are possible, if not likely. At the present time, no PCS has been found as a result of a windshield survey and resident surveys have not been distributed. Additional PCS sites will be added to the SWA map as they are found. The process for completing the inventory is included as appendix 6.

### Permitted potential contaminant source-generators for the Zeba source water area

Site Name/location	Latitude	Longitude	Permit Number	Approximate distance from PCS to Zeba intake (ft)	Reason for Permit	Reason for listing as Potential Contaminant Source
Celotex Corp	N46°45'23"	W88°27'22"	MID006129332	20,000	Release or Manufacturing of Toxic Compounds	Toxic Release Inventory
Baraga WWTP	N46°46'54"	W88°29'30"	MID985631068	19,300	Waste Water and (or) Process Water	Permit Compliance System
UP Power Zeba	N46°45'21"	W88°27'22"	MID980006720	20,200*		
Zeba WWTP	N46°45'18"	W88°27'12"	MID985657048	20,200*		
Baraga WFP	N46°46'50"	W88°29'20"		18,850		
Baraga WWTP	N46°46'54"	W88°29'30"	MI0022250	19,300	Cooling, Process, Treatment, and (or) Waste Waters	Industrial Facilities Discharge System
Baraga Water Treatment Plant	N46°46'50"	W88°29'20"	MI0024881	18,900		
UP Power Zeba	N46°45'21"	W88°27'22"	MI0006092	20,200*		
Zeba WWTP	N46°45'18"	W88°27'12"	MI0020133	20,200*		
Kens Service	N46°46'24"	W88°29'36"	MID044395861	21,200	On-Site Storage	Hazardous or Solid Waste Site
Zeba, Village of Garage	N46°45'31"	W88°27'13"	MID981775422	19,000*		
Pettibone Michigan Corp	N46°45'59"	W88°29'51"	MID006129373	23,500		
MIDOT	N46°44'52"	W88°26'37"	MID980992234	22,000		
Northern Painting and Coatings	N46°46'29"	W88°29'31"	MID001026756	20,600		
Thomas Ford Mercury	N46°45'29"	W88°27'16"	MID017187303	19,300		
Upper Peninsula Power Warden Station	N46°45'24"	W88°27'21"	MID980006720	19,900		
Zeba, Village of	N46°45'05"	W88°26'39"	MID981780141	20,800*		
Baraga Products Inc	N46°46'35"	W88°29'26"	MID106634272	20,000		
Celotex Inc	N46°45'23"	W88°27'22"	MID006129332	20,000		
Nicks Standard Service	N46°45'26"	W88°27'12"	MID041414160	19,500		

*Note that several sites or businesses have more than one type of potential contaminant, which results in them having more than one entry in the table shown above. The distance from the PCS to the water intake is probably erroneous for several of the entries because the permit address appears to be a business office address, rather than the source location. Assumed erroneous distances are identified by a \* in the preceding table. It would be prudent for the SWA&PP group to verify the actual location of the PCS, e.g., U.P. Power in Zeba, and obtain GPS coordinates at that time and revise the preceding table, as appropriate.*

There are additional known potential entry points for contamination into the SWA. They include, but are certainly not limited to industrial parks in L'Anse and Baraga and any number of locations within the SWA that are impacted by forestry practices. Forestry practices known to impact the SWA include erosion at stream crossings, spillage of petroleum products, e.g. spilled fuel, hydraulic oils, and lubricants, and application of

pesticides and herbicides on vegetation within the SWA. Unfortunately, the transient nature of the forestry products industry makes locating potential contaminant sites difficult to locate. The exception is stream crossings, which are relatively easy to locate. The KBIC Forestry Department may be able to assist with compilation of these types of locations within the SWA.

## **B.4 SUSCEPTIBILITY DETERMINATION**

The Zeba water treatment plant (WTP) has historically treated the source water to meet drinking water standards with minimal problems or complaints from water consumers. None the less, the system is determined to be *highly susceptible* to contamination by virtue of construction characteristics, e.g., depth below water and distance from shore, historical contaminant detections, prevalent soil types, and proximity to known potential sources of contamination (appendix 3, p.7). Typical of most surface water sources, the Zeba PWS would be easily impacted under the right circumstances, whether they are accidental or malicious. The SWA&PP and Contingency Plan (appendix 5) should enable the Zeba PWS operators and KBIC Environmental Staff to react rapidly to problems within the delineated watershed area. The contingency plan has identified a strategy KBIC will follow for supplying an emergency short-term supply of potable water should the Zeba PWS be rendered unusable by either accidental or malicious contamination and considers longer-term alternatives should the system be rendered unusable for an extended period of time.

### **Historical Contaminant Detections**

Total low-service pumping capacity for the Zeba water plant is 30,000 gallons per day (GPD) (Indian Health Service, 1999). ). The Zeba WTP serves about 110 service connections, which varies between 300 and 500 residents. Treatment includes tri-media pressure pre-filtration, duplex bag filtration, chlorination, and fluoridation. The WTP has an above-ground, 67,000-gallon (gal), welded-steel standpipe for storage. Water quality is good, but raw water quality occasionally experiences a small increase in turbidity and coliform, possibly related to wind/current conditions, allowing Linden Creek and L'Anse water treatment plant discharges to migrate northward to the Zeba water plant intake (appendix 3, p.8).

Currently, Zeba water plant is undergoing an extensive upgrade to both increase its capacity and to bring it into compliance with current PWS codes and regulations. Upon completion, a narrative covering the upgrades will be included in Worksheet 16.

Monitoring for Volatile Organic Contaminants (VOCs) occurs annually. The next sampling is to occur for the 2003 Compliance Period. Historical (VOC) detections are listed below. In 2002, detections at the Method Detection Limit (MDL) of 0.5ug/L occurred for the following analytes: Xylenes. Trace detections of Dichloromethane were also observed. Monitoring frequency cannot be further reduced and because the detections were at or below the (MDL), the frequency requirement did not increase.

## ***C.1 STRATEGIES FOR PROTECTING DRINKING WATER SOURCES***

### **Building a Source Water Assessment Protection Program**

Once a SWA&PP is completed, the focus shifts to protection. New information should be added as it becomes available, as the SWA&PP becomes a “living” document. The SWA&PP uses information collected during the assessment phase to develop community-based strategies for long-term protection of the source water. Public notification and participation play pivotal roles in the process, giving the public input into the process. Protection strategies do not have to represent large departures from current Tribal laws, policies, and restrictions, and could simply require enforcement of current laws, codes, and ordinances. The biggest complication with the source water area for the Zeba water plant is that its Source Water Area extends beyond Tribal control into Keweenaw Bay. The SWA&PP Group plays a key role in the entire process, weighing the advantages and limitations of various management strategies, and assessing their ultimate value to the SWA&PP.

### **Non-regulatory Strategies**

Non-regulatory strategies are considered the least-costly, but possibly less effective method of choice for KBIC, given the limited amount of resources available. The following are just a few examples of the strategies KBIC has used in the past and/or plans to use in the future:

- A continuing public education program for tribal residents within the Source Water Area, as well as non-tribal residents near the Source water Area. This includes dissemination of the (SWA) to inform the public and also programs, flyers and signs that encourage voluntary protection and conservation.
- Water Quality monitoring of Keweenaw Bay. KBIC has been monitoring the bay waters at three sites for 2 years as part of an ongoing, four-year EPA CWA 106 surface water monitoring program. It is hoped that this will continue in the future.
- Land purchase within the Reservation and the Source Water Area is ongoing, depending on funding and availability.

### **Regulatory Strategies**

KBIC has a limited range of regulatory strategies that are available due, in part to the large size of the (SWA) and the limited amount of tribal-owned land within it. In the future, KBIC may consider codes or ordinances that restrict or regulate the use and/or storage of hazardous chemicals or materials, on tribal land. Other strategies such as land-use regulations or codes, buffer zones or setbacks, may be utilized in the future.

## WORKSHEET 15 Evaluation of Management Strategies

### EVALUATION OF MANAGEMENT STRATEGIES

The following worksheet should be used to help evaluate the worth of various strategies for minimizing or preventing contamination of drinking water sources. It contains a more extensive list than the narrative above.

Option	Advantages	Limitations	Resources needed
Public Education	Inexpensive, simple to implement	Relies on voluntary public response	Brochures, fliers, signs, posters,
Water conservation	Free, little effort required	Relies on voluntary public response	Public education, or a volume-based rate structure.
Keweenaw Bay water monitoring	Advance notice of potential trends/problems	Funding, staff	Funding
Regulation of use/storage of hazardous materials	Addresses possible contaminants, directly. Increases overall safety of the area.	Requires training of staff. Requires monitoring to insure compliance. Relies on current regulations, further regulation could be costly and time-consuming	Enforcement, monitoring, training, equipment, possibly containment facilities.
Land use regulations	Control over more of the (SWA)	Can only regulate tribal land.	Time and funds to adopt new regulations. Area studies.
Land purchase	Greater control over the (SWA)	Costly. Availability of land for purchase.	Funding and available land.
Spill response plans for most significant (PCS's)	Greater control and better response to spills/contamination. Can also be incorporated into the (PWS) contingency plan in the future.	Enforcement requires compliance	Time, staff, funding, training and equipment

## WORKSHEET 16

### SOURCE WATER PROTECTION PROGRAM CHECKUP

Used to update information and include listing of new, or previously unlisted, surface water intakes, delineations, and facilities in the protected area. Additionally, try to incorporate any changes within the SWA that might increase the potential for contamination, contingency plans, or strategies used to maintain or expand the SWA&PP. Some example questions are included below.

- 1) List any new facilities in protected areas since the last update.
- 2) List any changes in existing sites that may increase the potential to contaminate the Keweenaw Bay watershed.
- 3) Describe changes made to, maintenance performed on, intake structures, piping, etc. to the Zeba water intake.
- 4) Were contingency plans implemented at any time since last update? If so, what changes, if any, are needed in the contingency plans?
- 5) Were any new management strategies introduced since previous update? If so, describe the strategies and the reason for their adoption.
- 6) Describe any environmental changes that have affected the source water and the surrounding land such as forest fires, flooding, etc.

## Selected References

- Harrington, M.W., 1895, The surface currents of the Great Lakes: U.S. Weather Bureau, Bulletin B.
- Lusch, D.P., Rader, C.P., Barrett, L.R., and Rader, N.K., 1992, Aquifer vulnerability to surface contamination in Michigan: Center for Remote Sensing and Department of Geography, Michigan State University, East Lansing, MI, scale 1:1,500,000.
- Martin, H.M., 1955, Map of the surface formations of the southern peninsula of Michigan: Michigan Geological Survey, Department of Conservation, Publication 49, scale 1:500,000, 2 sheets.
- Michigan Department of Environmental Quality, 1999, State of Michigan source water assessment program, 153 p.
- Michigan Section, American Water Works Association and Michigan water Environment Association, 2001, Source water protection, a joint position statement, 2 p.
- Miller, J.B. and Twenter, F.R., 1986, Michigan surface-water resources, *in* U.S. Geological Survey, National Water Summary 1985—hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 277-284.
- Milstein, R.L., compiler, 1987, Michigan sesquicentennial, 1837-1987, bedrock geology of northern Michigan: Michigan Department of Natural Resources, Geological Survey Division, scale 1:500,000.
- Minnesota Department of Health, 2003, Source water protection guidance document: *an incomplete draft version provided by Beth Kluthe, Minnesota Department of Health*, 42 p.
- MIRIS, 2000, Michigan Resource Information System: Michigan Department of Natural Resources, Land and Water Management Division, 2 compact discs, as updated.
- National Oceanic and Atmospheric Administration, 2000, Climatological Data, Michigan: U.S. Department of Commerce, 114:13.
- Sweat, M.J., 2001, Source water assessment report for the Zeba water supply, Michigan Source Water Assessment Report 70: U.S. Geological Survey – WRD, Michigan Department of Environmental Quality, Drinking Water and Radiological Protection Division, 16 p.
- Totten, Glenn, 2000, Protecting drinking water: a workbook for Tribes: Water education Foundation, *and modified by U.S. EPA Region 5*, 108 p.
- U.S. Department of Agriculture, 1988, Soil survey of Baraga County area, Michigan: unnumbered report, 306 p., 62 sheets.
- U.S. Environmental Protection Agency, 1998, Better assessment science integrating point and nonpoint sources: BASINS Version 2.0. EPA 823-B-98-006, variably numbered.
- U.S. Environmental Protection Agency, 2000, Assessment protocol for Great Lakes Sources: final draft (revised 6/6/00) by Great Lakes Protocol Workshop: 6 p.
- Van Luven, D.M., Huntoon, J.E., and Maclean, A.L., 1999, Determination of the influence of wind on the Keweenaw Current in the Lake Superior Basin as identified by advanced very high resolution radiometer (AVHRR) imagery: Journal of Great Lakes Research, vol. 25, no. 4, p. 625-641.

## Appendices

**Appendix 1**  
**Assessment Protocol for Great Lakes Sources-excerpted**

## **Assessment Protocol for Great Lakes Sources-excerpted**

In 1996 when the federal Safe Drinking Water Act was reauthorized, legislation was added that requires source water assessments be performed on all sources of public drinking water supplies. The assessments must consider the vulnerability of these public drinking water sources. Assessments of intakes that extend into the Great Lakes present a unique challenge in determining the scope and magnitude of these assessments with limited resources. The intakes for some of these sources extend far enough into a lake to receive no effects from specific shoreline contaminant sources (except possibly air borne contaminants) while others closer to shore do. To provide guidance on how source water assessments should be performed, it will be necessary to address this very basic premise. USEPA may be able to give some assistance by providing access to data bases, developing screening methods and area wide monitoring for general contaminants, general lake responses to airborne contaminants, and other area wide general assistance.

A workgroup from the Great Lakes States is being organized to develop these parameters. This workgroup includes representatives of the Great Lakes States, water utilities with intakes on the Great Lakes, USEPA Region V and other interested parties. There should be consensus among the states and USEPA on the make up of the group. USEPA and the Region V states met on June 16, 1999 to develop a mission statement and a final draft of this protocol. The following mission statement defines the intent of the workgroup.

*The mission of the Great Lakes Protocol Workgroup is to develop a consensus amongst the states for a consistent procedure allowing the flexibility necessary to properly conduct source water assessments of our Great Lakes drinking water sources. This flexibility will take into account the variability of these sources and site-specific concerns for determination of source sensitivity and susceptibility.*

### **Initial Survey**

An initial survey will be performed at each Great Lakes source to assess local source water impacts. Any criteria or studies that were performed to locate the intake should be reviewed. Senior operators and the plant superintendent at the treatment plant plus other local officials should be interviewed to gain knowledge of the raw water quality fluctuations. Past water quality records from files or existing databases would need to be reviewed and also any data collected through the Information Collection Rule (ICR). Bacteriological quality, alkalinity and turbidity levels are good indicators of localized impacts. If this review indicates that only minor fluctuations occur in raw water quality compared to the lake's background quality, the source is probably not impacted from localized contaminants and the assessment would parallel a general water quality assessment of the total lake with some consideration for potential emergency spills.

The "Great Lakes Surface Water Assessment Survey" form developed with this protocol can be utilized as a screening tool to assist in determining localized impacts. The initial survey should be used to assist with determining procedures to follow in conducting the survey. The assessment procedures will depend upon the type of local impacts, the availability and quality of local data, weather conditions, runoff, etc.

### Critical Assessment Zone

To provide some continuity for assessing the Great Lakes intakes, the concept of a "Critical Assessment Zone" (CAZ) around each intake was developed. The two factors used for this zone, which affect the sensitivity of Great Lakes intakes, are the **perpendicular** distance from shore or length of the intake pipeline (L) in feet and the water depth (D) **of the intake structure** in feet. The shallower, near shore intakes are more sensitive to shoreline influences than the off shore, deep intakes. The factor for sensitivity (S) can be calculated by the formula:

$$L \times D = S$$

Generally, S values less than 25,000 represent highly sensitive intakes while S values greater than 125,000 indicate lower sensitivities. This degree of sensitivity can be used by the states as a tool to prioritize assessment activities and assist with the susceptibility determination after taking contaminant sources into account.

The intake's degree of sensitivity combined with information obtained from the survey form and local data such as intake construction, lake bottom characteristics, localized flow patterns, thermal effects and **bethnic nepheloid layers** can be used to complete a sensitivity analysis. **The bethnic nepheloid layer is a zone of suspended sediment kept suspended by the interactions of current and sedimentation. The layer's characteristics around an intake depend on sediment density, water temperature, bottom currents and animal activity.**

The following columns represent Great Lakes intakes with high, medium and low sensitivities. A CAZ is defined as the area from the intake structure to the shoreline and inland. This area includes a triangular water surface and a land area encompassed by an arc from the endpoint of the shoreline distance on either side of the on shore intake pipe location. The shoreline distance (SL) is measured in feet in both directions from the intake pipe location on shore while the distance inland (DI) in feet is determined by subtracting the submerged intake pipe length (L) from the critical assessment zone radius (R). The drawing, which follows, illustrates an example of the Critical Assessment Zone.

Note: ~ indicates square root of parenthesized calculations.

<u>Sensitivity Value</u>	<u>Critical Assessment Zone</u>	<u>Shoreline Distance</u>	<u>Distance Inland</u>
--------------------------	---------------------------------	---------------------------	------------------------

<25,000	3,000 foot radius	$SL \sim (3000^2 - L^2)$	$DI = 3000 - L$
25,000-125,000	2,000 foot radius	$SL \sim (2000^2 - L^2)$	$DI = 2000 - L$
		$L > 2000; SL = 0$	$L > 2000; DI = 0$
>125,000	1,000 foot radius	$SL \sim (1000^2 - L^2)$	$DI = 1000 - L$
		$L > 1000; SL = 0$	$L > 1000; DI = 0$

### Completing the Assessment

If the assessment indicates the intake is not impacted by potential shoreline contaminants, the assessment should reference general Great Lakes water quality and trends within the source water assessment area. This information has been compiled by several sources such as the U.S. EPA's Great Lakes National Program Office (GLNPO) and the Great Lakes Mass Balance Studies done by the USEPA, the States, and USGS. GLNPO has conducted water and sediment modeling activities using National Oceanic and Atmospheric Administration 5 kilometer grids, which should be useful for modeling potential spill scenarios from sources such as pipelines, and for assessing tributary impacts. Another source could be the Remedial Action Plans for Great Lake Areas of Concern and the Lakewide Management Plans. Some of these sources address contaminants brought forth by air deposition. Total Maximum Daily Loads (TMDLs) should also be referenced, if available.

For systems where the initial survey indicates a potential for shoreline impacts, the assessment becomes more difficult and site specific. The next step would be to provide a delineation of the area that contributes potential impacts through the use of local data and/or the "Critical Assessment Zone" concept. It would then be necessary to assess the impacts in the area and their relative impact on the quality and treatability of the raw water. If a river or stream that discharges into the lake near the intake causes a significant impact, a partial watershed assessment of that river or stream would be necessary. These impacts may not be continual, but may arise only as a result of certain events such as a specific wind direction and intensity, or a river or stream discharge into the lake at a certain flow level. The USEPA BASINS software and USGS SPARROW software may provide data for this determination. There may also be impacts from certain thermal or seasonal conditions. The workgroup should develop criteria to determine "significant impact and level of impact". These issues will require extensive review of the water quality records and in depth interviews with plant personnel.

If the water quality impact is due more to a general lake condition, such as proximity to a shallow bay, wind direction or localized current patterns, the degree of these impacts must be assessed. Interviews with the plant personnel with extensive experience at the plant would be essential. Once the impacts are categorized, assessments must be made for each impact. For example, if a shallow bay causes water quality impacts, these impacts should be noted along with the change in water quality anticipated and the degree and frequency of change. If the quality change results from an algae bloom, the conditions that promote the bloom should be listed, along with the resulting water quality changes and the degree and frequency of the changes. Each impact should be listed in the narrative portion of the assessment.

If the impact results from a discharge on the shoreline, runoff from the shoreline, **local tributary** or location of a facility near the intake, these potential impacts should be listed and assessed. It may be necessary to delineate a susceptible area extending beyond the CAZ, determine the impacts in this area and then assess these impacts. This could become complex depending upon the shoreline assessment. If the impact were from runoff, it would first have to be assessed to determine the degree of impact due to the volume and concentration of contaminants in the runoff. Is the runoff significant? If it were, the potential makeup of the runoff would need to be assessed. For example, is the runoff from farmland? If so, the time of the year would be critical. If it were urban runoff, the types of commercial and industrial establishments in the area would be important. These assessments will be complex and must be designed so they can be altered and expanded, as more information becomes available. The assessment must be dynamic in nature designed for future expansion.

Many bays and tributary mouths in urban or industrialized areas hold deposits of sediment contaminated by metals and organic toxicants. Records of EPA and State environmental management agencies, as well as the U.S. Army Corps of Engineers Harbor Dredging Programs should be evaluated to determine whether an increase in turbidity due to material suspended in such sites might pose a risk.

Wind direction, thermal effects and local current patterns affect many intakes. The affects may be due to a shallow bay, or proximity to a shallow bay, where the bottom sediments are re-suspended into the intake water column or it may direct shoreline runoff over the intake. These impacts can be surveyed by delineating the susceptible area that contributes water to the general area and checking the potential contaminants in the area. Extensive interviews with plant personnel and review of historical records will be necessary. Once the impact has been determined, the assessment of the impact must be made. The list of contaminants associated with each impact must be listed.

Remote sensing, including aerial photograph and satellite imagery, can be extremely revealing both in analyzing a history of events and near real time tracking of tributary and nearshore phenomena.

To complete the assessment, the susceptibility determination should include a general map of the area, **the sensitivity analysis**, delineation of the contributing areas, and listing of the locations of the various impacts along with a narrative that explains these impacts. Three-dimensional hydraulic models can be valuable tools for use in areas where they have been developed.

Before public release of the completed assessment, it should be reviewed with the water supplier for agreement of its contents.

### **Spill Assessments**

Large volumes of materials are transported on the Great Lakes by shipping. Some of these materials are toxic in nature and are subject to accidental spillage during transit and loading. Ships also pose potential risks to intakes through accidental spills of fuel and lubricants.

When doing vulnerability assessments of the intakes, this traffic should be considered. If ships pass in close proximity to an intake, or if there is a nearby commercial loading facility or harbor, procedures should be established to respond to spills from these ships. It would not be possible to predict many specific contaminants from general shipping, but proximity of a particular industry serviced at a local harbor would indicate heightened risk potentials for specific products or supplies. Procedures could be developed for reaction to families of contaminants, such as volatile organic chemicals, pesticides, etc. Previous spills in the vicinity, if any, should be reviewed and assessed. The source should have a contingency plan for guidance in an emergency.

Spills along lakeshores or connecting river shorelines should also be assessed along with potential spills from pipelines, docking facilities, railroad lines, etc. For example, there are numerous chemical plants along the St. Clair River, which connects Lake Huron to Lake St. Clair. These potential sites should first be identified and located on a map if the initial survey indicates there may be impacts from these areas. Procedures then should be developed for assessing and reacting to these types of emergencies. Where possible on the connecting rivers, modeling of the river flows could be used to assess potential impacts on intakes. In these cases, the specific contaminant would normally be known and this information could be used in the assessment.

For intakes located close to the lakeshore lines, again the areas that could significantly impact the intake should be delineated. Potential spill sources in these areas such as industries; disposal facilities, highways, railroads; pipelines, etc. should be located, mapped and assessed. Depending upon the type of potential risk, the specific contaminant may be identifiable, but this may not always be the case. These spills should be considered differently from the routine discharges that may exist. A spill is a unique event, and emergency reaction would be necessary to deal with the potential impact.

Surveys of fixed facilities, pipelines, highway and rail corridors and shipping routes have generally been completed and can be obtained by contacting the local emergency planning committee or the area planning committee. These two groups should have inventories of oil and hazardous materials at fixed facilities and along transportation routes.

### **Potential Treatment Impacts**

The impacts from treatments at the intake should also be included in the assessments. Continual treatment for zebra mussels may cause development of other impacts on the finished water quality. Short-term treatments or impacts such as intake cleaning, dredging, construction, etc should also be included in the assessment.

### **Summary**

An outline of the general methodology to be used for Great Lakes intakes should be a main part of the source water assessment program for states in the Great Lakes Region. Due to the unique nature of each intake, each assessment will be site specific. Assessments of the Great Lakes water quality in general have been done by various agencies and these efforts should

be referenced not duplicated. The site-specific assessments, if done in close cooperation with the treatment plants and local surface water protection agencies, become valuable tools to future operations and planning.

**Appendix 2**  
**MSAWWA and MWEA Joint Position Statement**

## **MSAWWA and MWEA Joint Position Statement**

The Michigan Section of the American Water Works Association (MSAWWA) and the Michigan Water Environment Association (MWEA) issued a joint position statement in September 2001 detailing their interpretation of source water protection (SWP). The following introduction is largely excerpted from their position statement. Both associations are dedicated to protecting Michigan's waters with members supporting public involvement through awareness, willingness to support clean water activities, and promoting public health and public confidence in drinking water supplies. Source water protection is one of many barriers or safeguards available to a water supplier to protect public health, such as proper intake/well construction and maintenance, water treatment, operator training, and a host of other activities. The position of MSAWWA and MWEA is that wellhead protection (WHP) and SWP are synonymous for ground-water supplies, but that considerably more complex and diverse issues need to be considered for surface water supplies. The MSAWWA and MWEA recommend that communities using surface water sources adopt SWP programs utilizing elements similar to the state defined WHP programs. These seven elements include:

- Defining roles and duties of government units and water supply agencies
- Delineating a source water protection area for each water supply source, based on the state's defined source water area
- Identifying potential contaminant sources within each source water protection area
- Utilizing management approaches for protection of source water, including but not limited to education and regulatory approaches
- Creating contingency plans for public water supply sources including the location of alternate drinking water supplies
- Assuring proper siting of new water sources to minimize potential contamination
- Encouraging public participation

These elements have been applied successfully in WHP programs, and translate directly to SWP. The MSAWWA and MWEA believe that a program of this kind is necessary for protection of local drinking water sources. They do not believe that local efforts by themselves are likely to be sufficient. Although surface and ground waters intermix in the hydrologic cycle, contaminants can be transported much more quickly in surface water than in ground water, and over much greater distances. Responsibility for protection of source water extends far upstream of affected public water supply sources and their local, state, and national boundaries. For these reasons, protection of surface water supplies requires a wider sharing of responsibilities among government units than is typically necessary for WHP. For a SWP program to be effective for surface water supplies, the following issues should be addressed:

- Involvement of and commitment by government units throughout the watershed
- The appropriate source water protection area for a SWP program may encompass an entire watershed, and many potential contaminant sources within that watershed

- Management approaches on a watershed scale may require state, national, or international involvement
- Public participation must include planning and pollution prevention by residents living upstream of the public water supply source

At the local level, SWP is instituted through watershed management plans plus efforts such as hazardous material training, zoning, local ordinances, abandoned well management, illegal connection programs, storm water treatment, street and catch basin cleaning, and public education.

It is important that state, local, and Tribal authorities work together to accurately assess source water susceptibility. Since assessment criteria involve dynamic parameters, source water assessments should be periodically updated to prioritize additional SWP activities.

### **Appendix 3**

**U.S. Geological Survey Source Water Assessment, PWSID # 5293302, Zeba Water  
Supply, Michigan Source Water Assessment Report 70**

Source Water Assessment Report for the  
Zeba Water Supply  
November 2001



*The Village of Zeba Water Treatment Plant  
Zeba, Michigan*

**Prepared for:**

**Village of Zeba Water Supply**

**Prepared by:**

**U.S. Geological Survey, Water Resources Division, Michigan District**

**Michigan Department of Environmental Quality, Drinking Water and Radiological  
Protection Division**

**Michigan Source Water Assessment Report 70**

## Executive Summary

*The purpose of the Source Water Assessment is to analyze the sensitivity and determine susceptibility of a community's source of drinking water to potential sources of contamination.*

*Sensitivity is determined from the natural setting of the source water (raw water to the water treatment plant), and indicates natural protection afforded the source water. Using procedures established in the Great Lakes Protocol, Michigan Source Water Assessment Program, the moderately deep, offshore intake in Keweenaw Bay for the Zeba source water has a high degree of sensitivity to potential contaminants. When the effects of winds and lake currents, the influence of Linden Creek and the Falls River, and the potential influence of storm drains on the Zeba intake are considered, the Zeba intake is categorized as highly sensitive.*

*Susceptibility identifies factors within the community's source water area that may pose a risk to the water supply. The susceptibility determination provides information with respect to listed facilities and land areas within the source water area that should be given greater priority and oversight in implementing a source water protection program. The source water area for the Zeba intake includes 20 permits for potential contaminant sources, 14 permits for potential contaminant sources within the susceptible area held by 9 different facilities, 8 storm drains that discharge up-current of the intake, and urban, agricultural, and industrial runoff from the source water area into Keweenaw Bay. The potential contaminant sources, in combination with the highly sensitive intake, indicate that the Zeba source water is highly susceptible to potential contamination.*

*The Zeba source water is categorized as highly susceptible, given the geography of the source water area and potential contaminant sources within the source water area. However, it is noted that historically, the Village of Zeba Water Treatment Plant has effectively treated this source water to meet drinking water standards. The Village of Zeba has proposed upgrades of its treatment facilities that should mitigate potential threats to its source of drinking water that are identified in this report. This report explains the background and basis for these determinations.*

## Using this Assessment

Clean, safe drinking water is fundamental to the viability of any community. Protecting the drinking water source is a wise and relatively inexpensive investment in your community's future. The overall intent of this assessment is to provide background information for your community to use in developing a local source water protection program. The assessment benefits your community by providing the following:

- ***A basis for focusing limited resources within the community to protect the drinking water source(s).***  
The assessment provides your community with information regarding activities within the **source water area (SWA)** that directly affect your water supply. It is within this SWA that a spill or improper use of **potential contaminants** may cause these contaminants to migrate toward the water **intake**. By examining where the source waters are most susceptible to contaminants, and where potential contaminants are located, the assessment clearly illustrates the potential risks that should be addressed.
- ***A basis for informed decision-making regarding land use within the community.***  
The assessment provides your community with a significant amount of information regarding where your drinking water comes from (the source) and what the risks are to the quality of that source. Knowing where the resource is allows your community planning authorities to make informed decisions regarding proposed land uses within the SWA that are compatible with both your drinking water resource and the vision of growth embraced by your community.

- *A basis for dealing with future regulations.*

The assessment has been designed to functionally meet proposed requirements for surface-water supplies. Information needed to address regulatory needs and requirements has been collected and made available to your community through this report.

This source water assessment also provides the basis for a locally developed, voluntary source water protection program. Communities interested in voluntarily developing source water protection programs should contact the Michigan Department of Environmental Quality (MDEQ) or visit the Department web page at <http://www.michigan.gov/deq>.

## Introduction

In 1996, Congress amended the **Safe Drinking Water Act** and provided resources for state agencies to conduct source water assessments by identifying SWAs, analyzing the **sensitivity** of the source to natural conditions, conducting contaminant source inventories, and determining the **susceptibility** of the source to potential contamination. Delineations, sensitivity analyses, contaminant inventories, and susceptibility determinations comprise a "source water assessment." Assessments will be completed for every public water supply source in Michigan. To support this effort, the MDEQ Drinking Water and Radiological Protection Division established a partnership with the U.S. Geological Survey (USGS) to develop a method for conducting source water assessments for surface water supplies (Sweat and others, 2000; Sweat and others, 2001).

The requirements for public water supplies in Michigan to meet United States Environmental Protection Agency (USEPA) **maximum contaminant levels (MCLs)** provide some degree of assurance of safe drinking water; however, all systems are vulnerable to potential contamination. One of the best ways to ensure safe drinking water is to develop a local program designed to protect the source of drinking water against potential contamination. Not only does this add a margin of safety, but it also raises the awareness of consumers and/or the community of the risks of drinking water contamination. It is expected that source water assessment results will provide a basis for developing a source water protection program.

## Background

The Village of Zeba is located in Baraga County, on the eastern shore of Keweenaw Bay (fig. 1). The Zeba water treatment plant (WTP) was originally constructed in 1987. The present intake, constructed also in 1987, is an 8-inch (in) diameter ductile iron pipe, extending 800 feet (ft) offshore in 26 ft of water (1927 datum). The intake draws water from Keweenaw Bay through an intake that terminates 4 ft above the bottom of the Bay. Two 25 horsepower centrifugal pumps deliver raw water to the treatment plant. Total low service pumping capacity is 30,000 gallons per day (GPD) (Indian Health Service, 1999). The Zeba WTP serves about 110 service connections, with between 300 and 500 residents. Treatment includes tri-media pressure prefiltration, duplex bag filtration, chlorination, and fluoridation. The WTP has an aboveground, 67,000-gallon (gal), welded-steel standpipe for storage. The current treatment system does not meet the 1990 surface-water treatment rule because of performance problems with the duplex-bag filters. Additional requirements of the long-term enhanced surface water treatment rule will cause the existing plant to remain out of compliance without proposed modifications and upgrades.

The study area for evaluating the extent of the Zeba water supply SWA includes the lower watershed for Keweenaw Bay, including the communities of Baraga, L'Anse, and Zeba; the Falls River and Linden Creek; and numerous small storm drains on either side of the intake (fig. 1). Sources of information reviewed during this assessment included topographic maps, water supply monthly operation records, USGS and MDEQ reports, on site interviews, private consulting reports, Indian Health Service records, and local, state, and Federal databases. A source-water assessment has been completed for the L'Anse WTP, and is the basis of this assessment.

A new water treatment process was proposed for Zeba in 1999, but has not yet been instituted. A sanitary survey has not been completed for the Zeba WTP. Public water supplies are periodically inspected by MDEQ to identify construction, maintenance, operational or source defects that could make them vulnerable to contamination, particularly from contaminants that are microbial in nature, such as fecal coliforms. Water suppliers are then provided a sanitary survey report that notes any deficiencies in the system, and the state may direct the system to make necessary corrections. Although Indian Health Service (IHS) water treatment facilities are generally exempt from State regulatory requirements, a sanitary survey is an important

# **Zeba Source Water Area (SWA)**

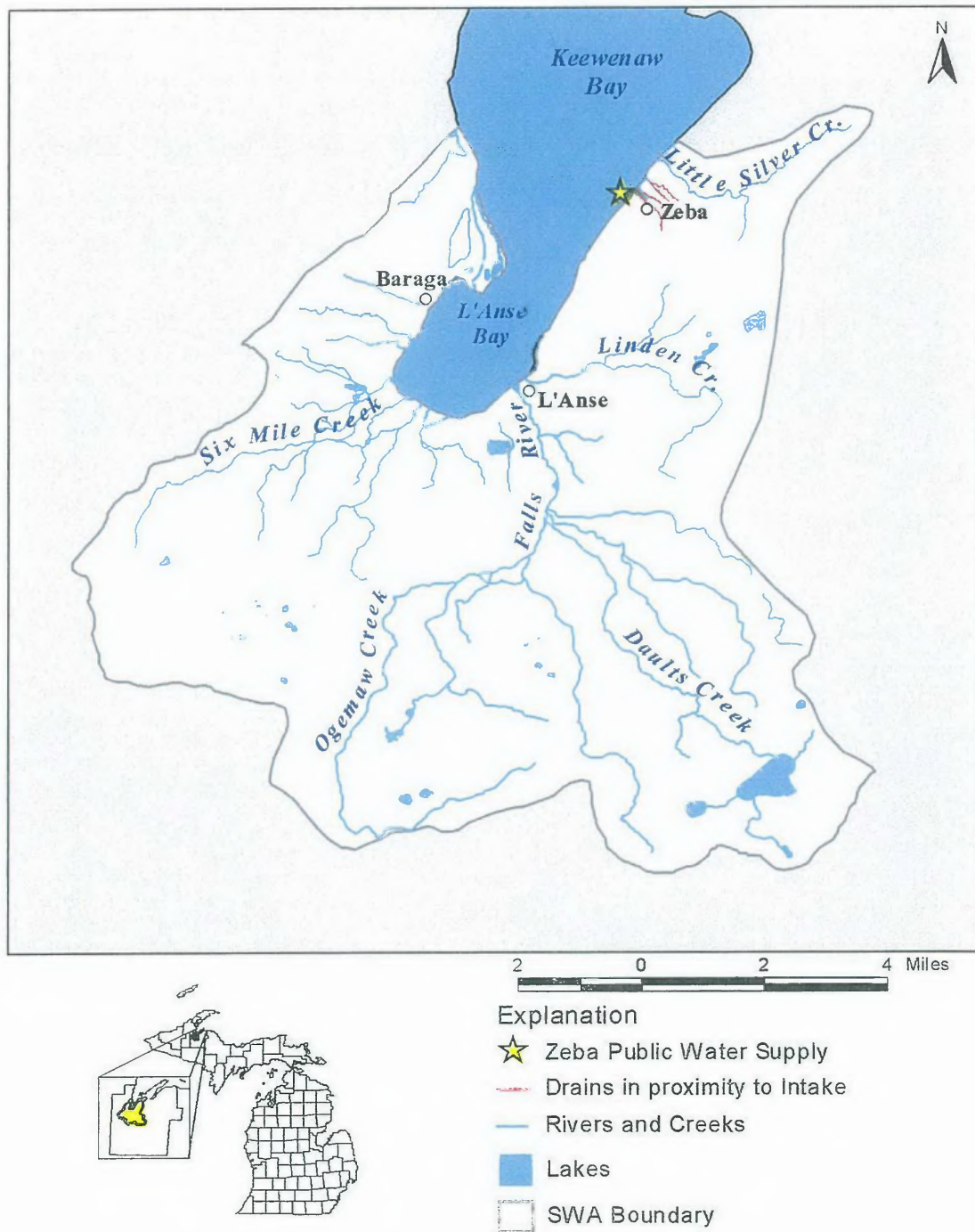


Figure 1. Source-water area for the evaluation of the Zeba water supply, Zeba, Michigan.

part of a safe drinking water program. IHS and Zeba should consider contracting for a sanitary survey once the new water treatment facility is completed.

### Climate

The Zeba water supply is located in the Northern Upper Peninsula hydrologic province (Rheume, 1991), in the Dead-Kelsey watersheds near both the Falls River and Linden Creek (USGS, 1974, 1982). The region experiences temperate summers with moderate to severe winters. Nearby National Weather Service stations report that average annual precipitation for the climatic years 1957-1999 was 43.5 in, and the average for the past 5 years was 34.1 in (NOAA, 1999), with about half of that as snowfall between October and March. Annual average runoff for the Zeba SWA, extrapolated from Miller and Twenter (1986, fig. 1) is 18 to 20 in, with the higher runoff values closer to the west side of Keweenaw Bay.

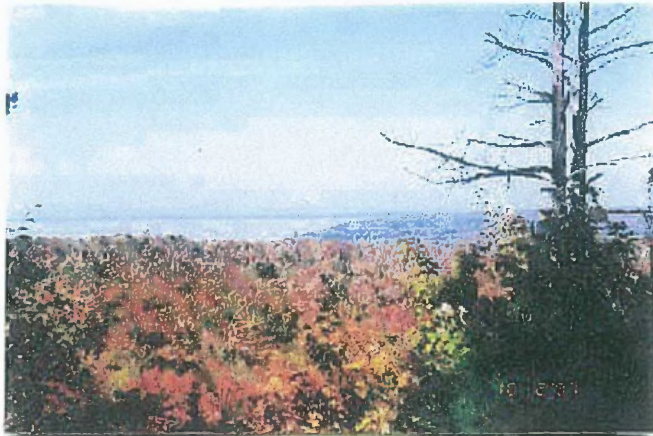
### Source Water Area Geology and Hydrology

The study area for evaluating the extent of the Zeba WTP SWA includes the lower Keweenaw Bay watershed, including the Falls River and Linden Creek (fig. 1). Zeba lies within the Dead-Kelsey watershed, and is situated between L'Anse Bay, the southern end of Keweenaw Bay on Lake Superior, and Pequaming Bay. Adjacent upland areas are primarily thin glaciated deposits, underlain by Keweenawean and St. Croixan sandstones (Martin, 1955; Milstein, 1987). Soils underlying the Zeba SWA are from the Keweenaw, Munising, and Zeba soil complexes (U.S. Department of Agriculture, 1988; BASINS, 1998; MIRIS, 2000). They include sands, sandy loams, and combinations.

Soil permeability is based on the calculated time of travel, in inches per hour (in/hr), for water to move vertically through a saturated soil zone. Soil thickness and permeability values are available in soil survey reports published by the National Cooperative Soil Survey and U.S. Department of Agriculture (1988). Permeability ranges from less than 0.06 in/hr, rated as very slow, to more than 20 in/hr, rated as very rapid.

Very slowly permeable soils significantly reduce the movement of water through the soil zone and, as a result, allow greater time for natural degradation of contaminants. However, such soils also provide for rapid overland transport of contaminants directly to receiving waters, which in turn may affect the water supply intake. In contrast, very rapidly permeable soils allow for rapid infiltration and passage through the soil zone from the surface. Such soils potentially allow rapid transport of contaminants with minimal contact-time available for contaminant breakdown.

Erosion and transport of soils by surface waters can cause an increase in turbidity.



Keweenaw Bay from Little Mountain, Baraga Countv. Michigan

Mean, area-weighted, depth-integrated permeabilities for the Zeba SWA range from 1.3 to as much as 13.0 in/hr. The mean permeability is 7.15 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998; MIRIS, 2000). Soil permeabilities range from moderately rapid in the northern part of the SWA to rapid in the southwestern and southeastern parts of the SWA (fig. 2; U.S. Department of Agriculture, 1961; Lusch and others, 1992; BASINS, 1998; MIRIS, 2000). These soils and the plant communities that thrive on them are the source of natural **tannins** and **lignins** to the water. Tannins impart a brown color to the water, and together with naturally occurring lignins (proteins similar to those of egg whites) may cause foam to form on the surface of the water where it is highly oxidized, such as where it flows over rocks,

rapids, or dams. In general these naturally occurring tannins and lignins are harmless; however, in addition to coloring the water, they can also impart tastes and odors to the waters when found in sufficient quantities. These natural occurring, organic materials are also precursors that contribute to the formation of trihalomethanes through chlorination at the water treatment plant. Erosion and transport of soils by surface waters can cause an increase in turbidity.

## Zeba Source Water Area Soil Permeability

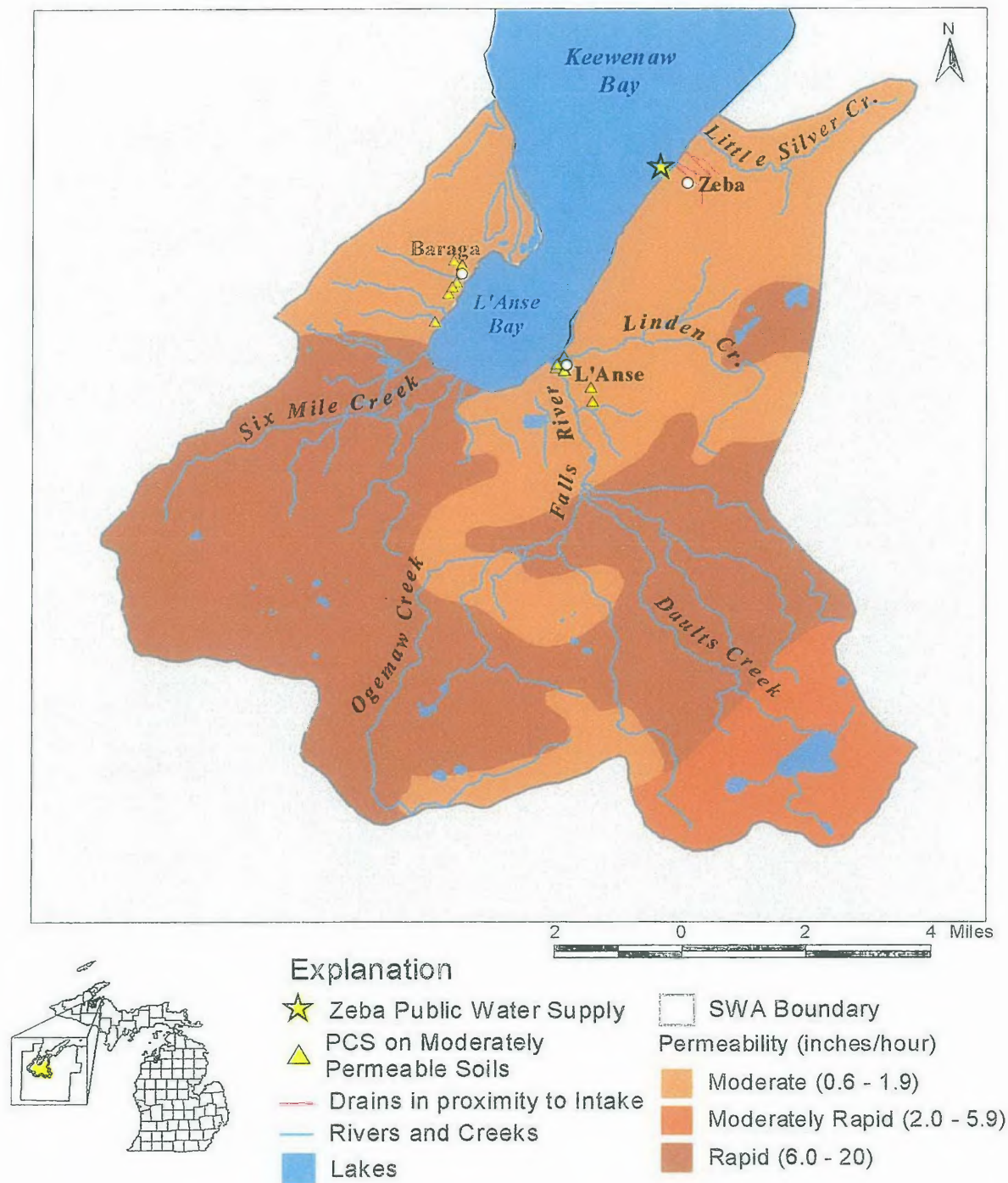


Figure 2. Soil permeability with identified potential point-source contaminant sources within the Zeba source water area, Zeba, Michigan.

The Zeba SWA contains an area of about 98 square miles (mi<sup>2</sup>) and is directly connected to L'Anse and Keweenaw Bays. The most significant tributaries to L'Anse Bay from the SWA are the Falls River, with a drainage area of about 45 mi<sup>2</sup>, and Linden Creek, with a drainage area of about 12 mi<sup>2</sup>. In 1991, 12 discharge measurements were made at 11 sites in the Zeba SWA (Sweat and Rheume, 1998). Water quality samples were collected at the time discharge measurements were made. In general, water quality met U.S. Environmental Protection Agency (USEPA) maximum contaminant level (MCL) guidelines for drinking water.

Under ambient conditions, currents in L'Anse and Keweenaw Bays are, typically, anticlockwise from the south-southwest (Van Luven and others, 1999; Harington, 1895) and pass over the Zeba WTP intake. Water from the Falls River and Linden Creek flows north from where they discharge to the Bay, and generally do not pass directly over the WTP intake under ambient conditions. Under certain wind conditions, however, lake currents can be altered, causing increases in turbidity and possibly coliforms. Other variations in wind conditions can cause the flow of the Falls River and (or) Linden Creek to pass over the intake, causing changes in water quality and chemistry at the intake.

### **History of Raw Water Quality at the Source**

Public water supplies are required to routinely monitor raw water quality for selected parameters to optimize treatment, and to monitor treated water quality for a list of contaminants that is determined by MDEQ and the Safe Drinking Water Act. A detection of any contaminant may indicate that a pathway exists for contaminants to reach the intake. It is important to realize that the results from a given sample only provide information regarding the water quality at the time the sample was collected. Water quality can change with time for a number of reasons. The fact that a water sample does not contain contaminants is no guarantee that contamination will not occur in the future. Conversely, the detection of a contaminant in the past does not indicate that it will occur in the future.

The Zeba WTP records show that annual water use is about 30,000 gpd. Water quality conditions have been monitored since the plant was constructed. An analysis of wind direction, water and air temperature, precipitation, observed discharge from the Falls River and Linden Creek, and source water chemistry for the L'Anse WTP indicates that there may be an indirect correlation between wind direction and turbidity, and perhaps wind direction and total coliform bacteria. Regression analyses of these data indicated that when the wind is from the west-southwest through west (245-270°) for more than 24 to 36 hours, there is a quantifiable increase in turbidity of the source water after 1 to 2 days, and possibly an increase in total coliforms after 2 to 3 days. This occurs because these sustained winds shift the circulation pattern in the Bay near the intake and cause water from the Falls River and (or) Linden Creek to pass over the intake. This increase in turbidity and total coliforms requires modifications to the treatment process. Because of the proximity of the Zeba WTP and intake to the L'Anse WTP and intake, these conditions are likely true also for Zeba WTP.

Seasonal variations associated with Bay water temperature also cause changes in raw water quality. As Bay waters warm in the spring and cool in the fall, waters in the Bay turnover due to density differences. This turnover results in higher turbidity as bottom sediments are disturbed and enter the water column. Turnover also causes occasional increases in the presence of total coliforms at the L'Anse WTP (Keith Mueller, personal commun., 2000), likely associated with the disturbed bottom sediments. The Zeba WTP periodically tested both raw and treated water for the presence of total coliform bacteria. Results indicate that fecal coliform bacteria are not present in the treated water.

### **Source Water Assessment Methodology**

Technical guidelines for completing source water assessments are contained in the Michigan **Source Water Assessment Program**, Assessment Protocol for Great Lakes Sources (Protocol) (MDEQ, 1999, Appendix L) available at <http://www.michigan.gov/deq>. In general, an assessment is a process for evaluating a drinking water supply and the potential for its treated water to exceed an MCL due to raw water contamination. A source water assessment considers the SWA, potential sources of contamination within the SWA, conditions of the water supply intake, and susceptibility to contaminants in order to identify potential risks to drinking water quality. Although the Protocol provides the minimum requirements and instructions on how to conduct an assessment, each water supply is unique with respect to how the process is carried out, due to local conditions and information. Sweat and others (2000, 2001) have developed and documented the methodology used in the preparation of this assessment.

## Delineating Source Water Areas

Delineation of the SWA is accomplished by using **geographic information system (GIS)** software to map the watershed(s) that have the potential to affect source water at the intake. Using information from the water supply, a **critical assessment zone (CAZ)** is defined for the intake (MDEQ, 1999, Appendix L). A buffer is then created along any shoreline intersected by the CAZ, and from the edge of the CAZ to the mouth of any river(s) that might influence the intake. Finally, the buffer is extended along the shoreline of any river(s) that might influence the intake, from the mouth of the river to its headwaters. The area defined by the CAZ, river and shoreline buffers is termed the **susceptible area**. The susceptible area within the SWA defines locations where a water supply should focus its management strategies and resources to benefit the drinking water resources.

Using the Great Lakes Protocol and the Zeba water supply information:

- The CAZ for the Zeba intake is calculated as:

$$800 \text{ (the length of the intake in ft.)} \times 22 \text{ (the depth of the intake in ft.)} = 17,600 \text{ (unitless)}$$

This results in a CAZ of 3,000 ft (MDEQ, 1999, Appendix L), and the intake is rated as highly sensitive (fig. 3).

- The susceptible area along the shoreline is calculated as:

The distance the CAZ extends inland (3,000 ft - 800 ft = 2,200 ft), from the point the CAZ intersects the shoreline to the western edge of the CAZ. The distance inland was determined from the end of the intake (fig. 4).

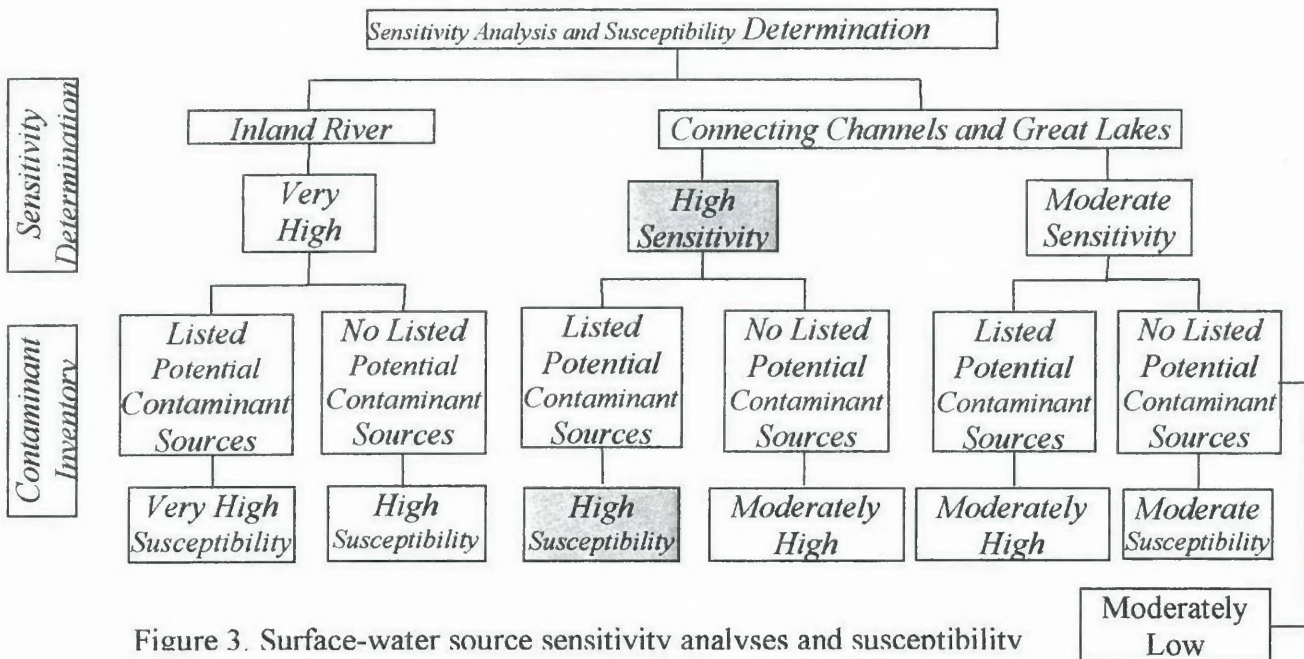


Figure 3. Surface-water source sensitivity analyses and susceptibility

\*Moderately Low Susceptibility determination is only applicable to deep, open water Great Lake intakes, free from littoral zone interferences, with excellent raw water quality histories, and where current flows and lake volume provide the potential for large volumes of dilution in the event of a spill or contamination event.

## Zeba Critical Assessment Zone (CAZ)



Figure 4. Critical assessment zone for the Zeba, Michigan water supply.

## Contaminant Source Inventory

Past, current, and potential future sources of contaminants were inventoried to identify several categories of potential sources of contaminants including microorganisms (bacteria, oocysts, and viruses), inorganic compounds (nitrates and metals), organic compounds (solvents, petroleum compounds, pesticides), and disinfection by-product precursors (trihalomethanes, haloacetic acids).

It is important to remember that sites and areas identified by this process are only **potential contaminant sources** (PCS) to the drinking water. Environmental contamination is not likely to occur when potential contaminants are used and managed properly. In addition, assumptions were made about particular types of land uses and risks associated with those land uses. Assumptions are discussed further in the results portion of this report.

The process for completing the inventory included several steps, which are summarized as follows:

1. Reviewed readily available land use maps and historical/current aerial photographs.
2. Plotted relevant information from applicable state and federal regulatory databases including the following lists:
  - MDEQ leaking underground storage tank (LUST) sites;
  - MDEQ registered underground storage tank (UST) sites;
  - MDEQ Environmental Cleanup Site Information System (ECSI) sites; MDEQ Source Information System (for water discharge permit sites including National Pollutant Discharge Elimination System (NPDES) permits, Water Pollution Control Facility (WPCF) permits, storm water discharge permits, and on-site sewage (septic) system permits);
  - MDEQ Underground Injection Control (UIC) database;
  - MDEQ Active Solid Waste Disposal Permits list;
  - Michigan Department of Transportation (MDOT) - Hazardous Materials database;
  - State Fire Marshall registry of above-ground fuel storage tank sites;
  - State Fire Marshall Hazardous Material Handlers and Hazardous Material Incidents (HAZMAT) sites;
  - U.S. EPA BASINS software, version 2.1.
  - U.S. EPA Envirofacts database;
  - U.S. EPA Resource Conservation Recovery Act (RCRA) generators or notifiers list;
  - U.S. EPA RCRA Treatment, Storage, and Disposal Facility (TSDF) Permits list;
  - U.S. EPA National Priorities List (NPL);
  - U.S. EPA Comprehensive Environmental Response, Compensation and Liability Information System (CERCLA) List;
  - U.S. EPA RCRA Corrective Action Activity List (CORRACTS);
  - U.S. Department of Transportation (DOT) Hazardous Materials Information Reporting System (HMIRS); and
  - U.S. EPA Toxic Chemical Release Inventory System (TRIS).
  - U.S. EPA Oil Pollution Act of 1990 Spill Response Atlas
3. Met with public water supply and IHS officials by phone during September and October, 2001, to identify potential sources not listed elsewhere in databases or on maps, and completed a preliminary inventory form used to compile the SWA base map. Conducted subsequent contacts by email and telephone on numerous occasions to request additional data, clarify data, and discuss results.
4. Land use and/or ownership (for example, residential/municipal; commercial/industrial; agricultural/forest; and other land uses) was mapped and evaluated in relation to PCS, soil characteristics, and proximity to the intake.
5. Completed final inventory form of PCS and plotted locations of PCS on the base map.

The purpose of the inventory is three fold: first, to provide information on the location of PCS, especially those within the susceptible area; second, to provide an effective means of educating the public about PCS; and third, to provide a reliable basis for developing a management plan to reduce potential contaminant risks to the Zeba water supply.

The inventory process attempts to identify potential point-source contaminants within the SWA. It does not include an attempt to identify specific potential contamination problems at specific sites, such as facilities that do not safely store potentially hazardous materials. However, assumptions were made about particular types of land use. For example, it is assumed that rural residences associated with farming operations have specific potential contamination

sources such as fuel storage, chemical storage and mixing areas, and machinery repair shops. It should also be noted that although the inventory depicts existing land uses, these are likely to undergo continual change due to normal crop rotation practices. What is irrigated farmland now may be non-irrigated farmland next year, or vice versa.

The results of the inventory were analyzed in terms of current, past, and future land uses and their relationship to the susceptible area and the supply intake. In general, land uses and PCS that are closest to the supply intake and tributaries to the source water pose the greatest threat to a safe drinking water supply. Inventory results are summarized in tables 1 and 2, and are shown on figure 5.

Table 1. Potential contaminant sources in the Zeba source water area

Type of potential contaminant source	Number of potential contaminant sources in the Source Water Area	Number of potential contaminant sources in the susceptible area
Hazardous or Solid Waste Site	11	9
Industrial Facilities Discharge Site	4	1
National Priority List Sites	0	0
Permit Compliance System	4	1
Toxic Release Inventory	1	1

Table 2. Potential contaminant source-inventory results for the Zeba SWA

Site Name	Permit Number	Reason for Permit	Reason for listing as Potential Contaminant Source
Celotex Corp <sup>a</sup>	MID006129332	Release or Manufacturing of Toxic Compounds	Toxic Release Inventory
Baraga WWTP <sup>b</sup>	MID985631068	Waste Water and (or) Process Water	Permit Compliance System
UPPower Zeba <sup>c</sup>	MID980006720		
Zeba WWTP <sup>d</sup>	MID985657048		
Baraga WFP <sup>e</sup>		Cooling, Process, Treatment, and (or) Waste Waters	Industrial Facilities Discharge System
Baraga WWTP <sup>b</sup>	MI0022250		
Baraga Water Treatment Plant <sup>e</sup>	MI0024881		
UP Power – Zeba <sup>c</sup>	MI0006092		
Zeba WWTP <sup>d</sup>	MI0020133		
Kens Service	MID044395861	On-Site Storage	Hazardous or Solid Waste Site
Zeba Village of Garage	MID981775422		
Pettibone Michigan Corp	MID006129373		
MIDOT	MID980992234		
Northern Painting and Coatings	MID001026756		
Thomas Ford Mercury	MID017187303		
Upper Peninsula Power Warden Sta <sup>c</sup>	MID980006720		
Zeba Village of	MID981780141		
Baraga Products Inc	MID106634272		
Celotex Inc <sup>a</sup>	MID006129332		
Nicks Standard Service	MID041414160		

## Potential Contaminant Source (PCS) map for Zeba,

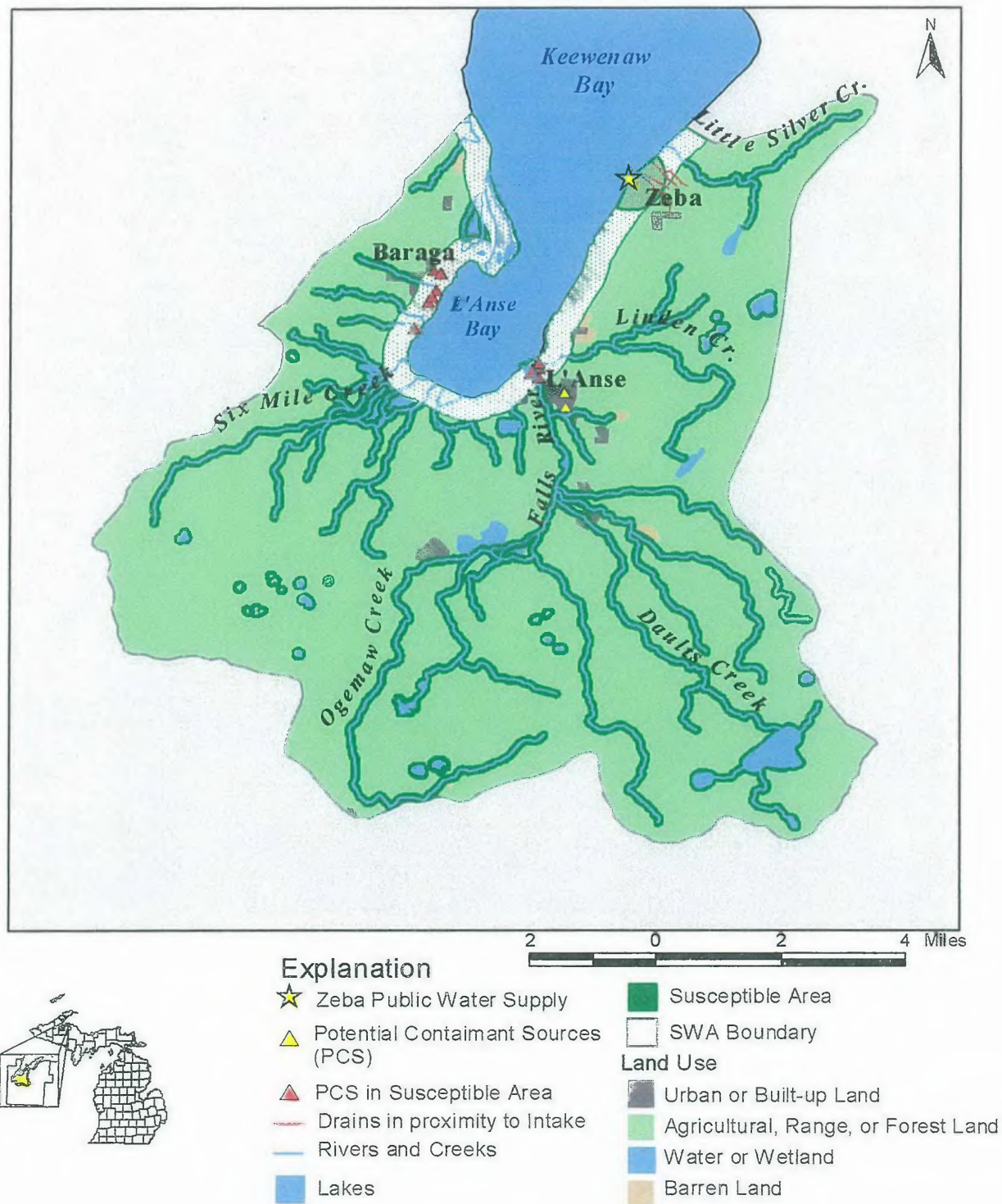


Figure 5. Identified potential point-source contaminant sources within the Zeba source water area, Zeba, Michigan.

Many PCS are readily identifiable because they have a single discharge point, and often a permit is required for these discharges. However, other PCS have diffused, poorly defined discharge locations. These are known as non-point discharges because they occur over large areas and may not be quantifiable by readily accepted methods. These non-point source discharges are difficult to identify and control, and consequently to quantify, yet they are a major source of water pollution (Carpenter and others, 1998). Non-point sources also include atmospheric deposition over water and land, and include urban, rural, and agricultural runoff from areas such as lawns, golf courses, farm fields, pastures, parking lots and roadways. Runoff from these areas can contain many types of pollutants including sediments, metals, organic and inorganic chemicals, viral and bacterial pathogens, pharmaceuticals, and animal wastes. Transportation also represents a non-point source of contamination. Trucking, railroads, and shipping all transport potential contaminants into or through the SWA. An accident causing a spill could lead to potential contaminants entering a storm sewer, or in the case of shipping, directly discharge to Keweenaw Bay. Non-point sources of concern to the Zeba water supply are primarily from agriculture and livestock in the Zeba SWA, and from industrial, commercial, and residential sources in Zeba, L'Anse, and Baraga.

Fifteen storm sewers and (or) drains discharge along the eastern shoreline of Keweenaw Bay. Eight of these drains are up current of the WTP, and 7 are down current of the WTP. The WTP operator reports that discharges from these drains do not affect the raw water at the intake because the flow remains close to shore. The U.S. Environmental Protection Agency (USEPA) has identified no **impaired water bodies** in the Zeba SWA on its Clean Water Act 303(d) list.

In general, PCS within the susceptible area pose greater risks than those outside the susceptible area. The presence of PCS within the SWA indicates potential sources of chemicals that could, if improperly managed or released, affect the water quality at the intake. A small quantity of these chemicals, in some cases a gallon or less, could significantly affect the supply. Also of concern is the location and distribution of these sources with respect to highly permeable soils. The susceptible area consists of primarily forested land, with some wetlands and agricultural lands. Overlaying the PCS locations and the moderately rapid to rapidly permeable soil map for the Zeba SWA indicates that none of the located PCS are located on or very near to areas with moderately rapid to rapidly permeable soils. All PCS within the SWA should be addressed; the susceptibility determination, however, provides the water supply with the tools to focus resources where the greatest risk occurs. The results of the PCS inventory performed for Zeba water supply is shown on figure 5 and is summarized as a function of PCS locations relative to the susceptible area. The inventory results indicate that there are 20 PCS, holding 14 permits for discharge within the susceptible area (table 2).

### **Sensitivity Analysis**

Sensitivity is the natural ability of a SWA to provide protection against the contamination of the water supply intake, and includes physical attributes of lakes, rivers, and soils. The sensitivity analysis requires consideration of several different variables related to the natural environment, for example:

- Water quality history of the source.
- Distribution of moderately rapid to rapidly permeable soils.
- Amount of available water from precipitation or runoff.
- Potential for runoff to affect the intake.
- Nature of the intake, including: depth, distance from shore, age, and materials used.
- Surface water flow patterns in vicinity of intake.

To perform this analysis, USGS, MDEQ, and the operator of the Zeba WTP collected, researched, and analyzed information from the WTP, monthly operator reports, sanitary surveys, soil maps, published reports, and historical plant operation and raw water quality data. The Zeba intake is 800 ft offshore in 26 ft of water, thus it has a CAZ of 3,000 ft, and the CAZ intersects the shoreline. The Michigan SWAP has three categories of sensitivity for surface water sources ranging from moderately sensitive to very highly sensitive. Analysis of this information, using guidelines provided in Sweat and others (2000, 2001), indicates that the Zeba intake is in the middle of this range or highly sensitive (fig. 3). This means that the natural environment offers little protection against contamination of the water supply intake.

### **Susceptibility Determination**

Susceptibility is the relative potential for contamination to reach the public water supply intake used for drinking water purposes. Whereas the sensitivity of a water supply is the natural ability of the area to protect the

intake against contamination, the susceptibility determination also takes into account other factors that will affect whether a contaminant reaches the intake. Whether or not a particular drinking water source becomes contaminated depends on three factors:

- (1) The distribution of PCS;
- (2) The source water area; and
- (3) The natural protection, or sensitivity, of the source.

In conducting a susceptibility determination, the part of the SWA that yields water to the water supply-system intake is identified by establishment of the susceptible area within the source water area. PCS within the susceptible area are then located. Based on the distribution of PCS within the susceptible area, the type of PCS, and the nature of the chemicals they use or store, PCS are analyzed for the risk they may represent to the water supply intake. Along with the presence and distribution of PCS, the sensitivity analysis is then used to determine the susceptibility of the water supply (fig. 3). This leads to a determination of whether the drinking water source is moderately susceptible, highly susceptible, or very highly susceptible to contamination (Sweat and others, 2001). It is important to understand that a system can have low sensitivity relative to some conditions (for example, intake construction and location), and high susceptibility because of other conditions (for example, the type of PCS). In Michigan, surface water sources of drinking water range from moderately low to very-high susceptibility.

When a public water supply is determined to have a moderate, high, or very high susceptibility because of a particular condition or set of conditions, there is a significant risk of contamination of the drinking water source because of that condition or set of conditions. Although the susceptibility determination does not predict when or if contamination will actually occur, it does recognize conditions that are highly favorable for contamination of the supply. In the event of a contaminant release to soils or surface water within the susceptible area, it is very likely that contamination at the intake would occur without completion of remedial actions.

If a public water supply's drinking water source is determined to be highly susceptible, it is recommended that the system identify the condition(s) that lead to the high susceptibility. Immediate steps should be taken to protect the source, and action should be considered to remedy the condition (for example, repairing or replacing faulty intake construction, working directly with facility operators to implement sound management practices, etc.).

All water supplies, regardless of their susceptibility, should consider identified factors that could lead to higher susceptibility in the future, and should prepare a strategy to protect the water supply source. Raising public awareness through signs and other education programs, encouraging proper intake construction and the use of best management practices in existing facilities are good ways of ensuring that a surface water source maintains its moderate susceptibility rating.

### **Summary and Recommendations**

The actual susceptibility of the drinking water source of a water supply depends on a number of contributing factors, some of which are only slightly related. Sensitivity is determined from the natural setting of the source and identifies the natural protection afforded to the source water. Susceptibility is determined by identifying those factors within the community's SWA that may pose a risk to the source water. The susceptibility determination provides information with respect to facilities within the SWA or land areas within the SWA that should be given greater priority and oversight in the implementation of a drinking water protection program.

**Sensitivity Analysis:** Based on criteria adopted in the Great Lakes Protocol of the Michigan Source Water Assessment Program, the moderately deep, offshore intake for the Zeba Water Treatment Plant has a high degree of sensitivity to potential contaminants. When considering the effects of winds and lake currents, and the influence of Linden Creek and the Falls River, and the potential influence of storm drains up-current from the Zeba Water Treatment Plant are considered, the Zeba intake is categorized as highly sensitive.

**Susceptibility Determination:** The SWA for the Zeba intake includes 20 listed potential contaminant sources holding 14 permits for discharge within the susceptible area, 8 storm drains that discharge to Keweenaw Bay between Pequaming and L'Anse, and urban, agricultural, and industrial runoff from the Source Water Area. Combining these potential

contaminant sources with the highly sensitive intake yields a highly susceptible determination for Zeba source water (fig. 3).

***Effective Treatment:*** While it has been determined the Zeba source water is highly susceptible to potential contamination, it is also noted the Village of Zeba Water Treatment Plant has, historically, effectively treated this source water to meet drinking water standards with minimal complaints from the public. This assessment provides the Village with a basis to institute a source-water protection program as another tool to assure the continued safety of its water supply, and to further justify the construction of a new filtration plant to better treat its water. The results of this assessment and the recommendations based on these results are summarized as follows:

- **Intake** - The Zeba Water Supply was originally constructed in 1987. The intake draws water 800 ft from shore, under about 22 ft of water (1927 datum), making it a highly sensitive intake.
- **Soils** - Using a mean, area-weighted, depth-integrated permeability estimation, the soil and subsoil material in the SWA range from 1.3 in/hr to as much as 13.0 in/hr. The mean permeability is 7.15 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998; MIRIS, 2000). About half of the soils in the Zeba SWA are moderately rapid or rapidly permeable; however, no PCS are located on these soils. These factors combine to make the SWA, and thus the intake, highly sensitive. The community should take steps to evaluate current and future land use in areas of highly permeable soils, particularly those occurring within the susceptible area. Residential areas that have been developed on these soils should be targeted for educational programs identifying steps that residents can take to protect the water supply.
- **Historical Contaminant Detections** - There have been no detections of synthetic or volatile organic contaminants in the systems raw water. Inorganic contaminants are typically at lake background levels. Nitrate concentrations are routinely below the detection limit. Positive coliform bacteria detections occur at the L'Anse WTP 2 to 3 days after Baraga empties its sewage lagoons, and the same is likely true of the Zeba WTP. The periodic presence of coliform bacteria is indicative of a relationship between water currents in the Bay and the intake location and runoff and soil conditions, causing the occasional presence of bacteria at detectable levels in the source water. These factors indicate that the SWA, and thus the intake, is highly susceptible.
- **Sanitary Survey** - The Zeba water treatment plant is an Indian Health Service facility that went on line in 1987, and as such is not subject to State of Michigan drinking-water regulations. Therefore, a sanitary survey does not exist for the Zeba water supply. It is important that the water supply follow good drinking water treatment and management practices.
- **Potential Contaminant Sources** - A review of the PCS inventory and the moderately rapid and rapidly permeable soil distribution indicates that the Zeba SWA has no PCS located on rapidly permeable soils. Within the SWA, there are 14 PCS with a total of 20 discharge permits. It is recommended that the community focus initially on PCS that are within the susceptible area as they pose the greatest potential threat to the water supply. These facilities should be made aware of free technical assistance that is available through MDEQ's pollution prevention programs. Through chemical inventory, waste reduction, and by increasing awareness of best management practices, the risk these facilities pose to source waters can be reduced. The PCS inventory indicates that the source is highly susceptible.
- **Source Water Assessment** - The Zeba source water assessment is based on these site-specific parameters:
  1. Definition of a Critical Assessment Zone around the intake for a highly sensitive source;
  2. Definition of a SWA for the Keweenaw Bay and the shoreline near the intake, Linden Creek, and the Falls River;
  3. Wind and current patterns in L'Anse Bay near the Zeba WTP intake and their effects on source water quality; and
  4. Listed and nonlisted potential contaminant sources.
- **Source Water Protection** - The Village should initiate source-water protection activities incorporating management plans, chemical containment, spill response, spill response training, and if applicable, an aggressive street cleaning program.

The Zeba WTP and/or the community should assemble a team to assist in the development and implementation of a source-water protection program that uses this assessment to further protect the Zeba source water area.

### Selected References

- Blumer, S.P., Behrendt, T.E., Ellis, J.M., Minnerick, R.J., LeuVoy, R.L., and Whited, C.R., 2000, Water Resources Data Michigan Water Year 1999: Water-Data Report MI-99-1, 365 p.
- Carpenter, S.R., Caraco, N.F., Correll, D.L., Howarth, R.W., Sharpley, A.N., and Smith, V.H., 1998, Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen, *Ecological Applications*, 8:3, 559-568.
- Hamblin, W.K., 1958, the Cambrian sandstones of northern Michigan: Michigan Geological Survey Publication 51, 146 p.
- Harrington, M.W., 1895, The surface currents of the Great Lakes: U.S. Weather Bureau, Bulletin B.
- Indian Health Service, 1999, Project Summary: Project BE-99-17R, 11p.
- Lusch, D.P., Rader, C.P., Barrett, L.R., and Rader, N.K., 1992, Aquifer vulnerability to surface contamination in Michigan: Center for Remote Sensing and Department of Geography, Michigan State University, East Lansing, MI, scale 1:1,500,000.
- Martin, H.M., 1955, Map of the surface formations of the southern peninsula of Michigan: Michigan Geological Survey, Department of Conservation, Publication 49, scale 1:500,000, 2 sheets.
- Michigan Department of Environmental Quality, 1999, State of Michigan Source Water Assessment Program, 153 p.
- Miller, J.B. and Twenter, F.R., 1986, Michigan surface-water resources, in U.S. Geological Survey, National Water Summary 1985—hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 277-284.
- Milstein, R.L., compiler, 1987, Michigan sesquicentennial, 1837-1987, bedrock geology of northern Michigan: Michigan Department of Natural Resources, Geological Survey Division, scale 1:500,000.
- MIRIS, 2000, Michigan Resource Information System: Michigan Department of Natural Resources, Land and Water Management Division, 2 compact discs, as updated.
- National Oceanic and Atmospheric Administration, 2000, Climatological Data, Michigan: U.S. Department of Commerce, 114:13.
- Rheume, S.J., 1991, Hydrologic provinces of Michigan: U.S. Geological Survey Water-Resources Investigation Report 91-4120, 73 p., 1 plate, scale 1:500,000.
- Sweat, M.J. and Rheume, S.J., 1998, Water resources of the Keweenaw Bay Indian Community, Baraga County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 98-4060, 33 p.
- Sweat, M.J., Erickson, P.M., and Brogren, B.B., 2000, The Michigan Source Water Assessment Program for Evaluation of Public Surface Water Supplies, in Bryant, Jeff, ed., NWQMC National Monitoring Conference 2000: Monitoring for the Millennium, Austin, TX, April 25-27, 2000.
- Sweat, M.J., Brogren, B.B., Loerop, M.W., Jodoin, R.S., and Rossi, T.A., 2002, Michigan's Source Water Assessment Program—Surface-Assessments Leading to Protection Initiatives, in, Watershed 2002, Proceedings of Watershed 2002, February 24-27, 2002, Fort Lauderdale, Florida, USA, 1 compact disc.
- Sweat, M.J., Brogren, B.B., Jodoin, R.S., and Rossi, T.A., *in press*, The Michigan Source Water Assessment Program – methods for the evaluation of public surface water supplies: U.S. Geological Survey Water-Resources Investigations Report 2001-xxxx.
- U.S. Department of Agriculture, 1988, Soil survey of Baraga County area, Michigan: unnumbered report, 306 p., 62 sheets.
- U.S. Environmental Protection Agency, 1998, Better assessment science integrating point and nonpoint sources: BASINS Version 2.0. EPA 823-B-98-006, variably numbered.
- U.S. Geological Survey, 1974, Hydrologic unit map—1974, State of Michigan: scale 1:500,000, 2 sheets.
- , 1982, Codes for the identification of hydrologic units in the United States and the Caribbean outlying areas: U.S. Geological Survey Circular 878-A, 115 p.

Van Luven, D.M., Huntoon, J.E., and Maclean, A.L., 1999, Determination of the influence of wind on the Keweenaw Current in the Lake Superior Basin as identified by advanced very high resolution radiometer (AVHRR) imagery: *Journal of Great Lakes Research*, vol. 25, no. 4, p. 625-641.

## GLOSSARY

**Critical Assessment Zone (CAZ)** – the area from the intake structure to the shoreline and inland, including a triangular water surface and a land area encompassed by an arc from the endpoint of the shoreline distance on either side of the on shore intake pipe location

**Geographic Information System (GIS)** – a system to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information

**Impaired water bodies** – water bodies that do not meet minimum specified criteria for use

**Intake** – the point at which source (raw) water is drawn into a pipe to be delivered to a water treatment plant

**Lignins** – an amorphous, cellulose-like, organic substance that acts as a binder for the cellulose fibers in wood and adds strength and stiffness to cell walls

**Maximum Contaminant Level (MCL)** – the maximum permissible level of a contaminant in water that is delivered to any user of a public water system

**Potential Contaminant Sources (PCS)** – listed and non-listed agricultural sites, businesses, and industries that have the potential to cause contaminants to be introduced into source water

**Sensitivity** – a measure of the physical attributes of the source area and how readily the attributes protect the intake from contaminants

**Source** – the water body from which a water supplier gets its water

**Source Water Area (SWA)** – the land and water area upstream and (or) onshore of an intake that has the potential to directly influence the quality of the water at the intake

**Source Water Assessment Program (SWAP)** – in Michigan, the process defined by the state Department of Environmental Quality to complete assessments of all the state's public water supplies

**Susceptibility** – identifies factors that may pose a risk within the community's source water area

**Susceptible Area** – the area defined by the critical assessment zone and a buffer on either side of any drainages that contribute water to an intake

**Synthetic Organic Contaminants (SOC)** – manmade organic chemical compounds such as pesticides, etc.

**Tannins** – naturally occurring phenolic compounds that precipitate proteins, alkaloids, and glucosides from solution that has a yellowish appearance

**Volatile Organic Contaminants (VOC)** – unnatural, volatile organic chemical compounds such as gasoline components, solvents, degreasers, etc.

## **Appendix 4**

**Minnesota Department of Health, Draft Document**

## Minnesota Department of Health, Draft Document

### Goals For Source Water Protection Planning

The goals of Minnesota's source water protection program for surface water systems is to:

- Address contaminants that can potentially impact the **acute and chronic health of human beings**
- Engage appropriate parties such that **implementation buy-in** is accomplished
- Reduce the incidents of potential drinking water contamination by **establishing barriers of protection** before the source water reaches the treatment plant
- Increase awareness of drinking water protection through **information and education**
- Provide a **sustainable source water resource**
- Provide for **cost-effectiveness**
- Build an **aesthetic acceptance and confidence** by the user
- Accomplish **pollutant reduction** in light of the need to balance demands of multiple users of the resource

## **Appendix 5**

**Source Water Assessment and Protection Plan, Contingency Plan, Zeba Public Water System, Keweenaw Bay Indian Community, Baraga County, Michigan.**

**Source Water Protection Program Contingency Plan  
Village of Zeba, Keweenaw Bay Indian Community,  
Baraga County, Michigan**

U.S. DEPARTMENT OF THE INTERIOR  
U.S. GEOLOGICAL SURVEY

*By* T. L. Weaver

# **Source Water Protection Program Contingency Plan Village of Zeba, Keweenaw Bay Indian Community, Baraga County, Michigan**

## **GENERAL INFORMATION**

The Village of Zeba is located in Baraga County, on the eastern shore of Keweenaw Bay. The Zeba water treatment plant (WTP) was originally constructed in 1987. The present intake, constructed also in 1987, is an 8-inch (in) diameter ductile iron pipe, extending 800 feet (ft) offshore in 26 ft of water (1927 datum). The intake draws water from Keweenaw Bay through an intake that terminates 4 ft above the bottom of the Bay. Two 25 horsepower centrifugal pumps deliver raw water to the treatment plant. Total low service pumping capacity is 30,000 gallons per day (GPD). The Zeba WTP serves about 110 service connections, with between 300 and 500 residents. Treatment includes tri-media pressure pre-filtration, duplex bag filtration, chlorination, and fluoridation. The WTP has an aboveground, 67,000-gallon (gal), welded-steel standpipe for storage. The current treatment system does not meet the 1990 surface-water treatment rule because of performance problems with the duplex-bag filters. Additional requirements of the long-term 1 enhanced surface water treatment rule will cause the existing plant to remain out of compliance without proposed modifications and upgrades.

A new water treatment process was proposed for Zeba in 1999, but has not yet been instituted. A sanitary survey has not been completed for the Zeba WTP.

## **SHORT-TERM EMERGENCY WATER SUPPLY OPTIONS**

1. Water could be purchased from either L'Anse or Baraga public water supplies, if their systems are unaffected by contamination or other problems that have caused the Zeba public water supply (PWS) to become unusable.
2. Purchase water from a nearby community with public water supply wells or a domestic supply well with sufficient capacity to fill tank trucks. It is anticipated that this may require some coordination with L'Anse and Baraga, since it is possible their water intakes will also be impacted.
3. Purchase water from a surface water supply that is unaffected by contamination or other problem, such as City of Houghton or Adams Township.

## **LONG-TERM ALTERNATIVE WATER SUPPLY OPTIONS**

Depending upon the type of surface water contamination, or other problem related to the Zeba PWS, and other related unknowns, possible long-term options are the following:

1. Construction/installation of a treatment facility that sufficiently removes contaminants.
2. Connection with community water supplies at L'Anse or Baraga if they are unaffected by the contamination present in the Zeba PWS. This is an unlikely scenario, given the proximity of the intakes to each other.
3. Development of a new surface water intake site, or public water supply wells.
4. Combination of the above.

## **EXISTING POTENTIAL CONTAMINANT SOURCES:**

Potential contaminant source-inventory results for the Zeba source water area are included in the SWPP.

There are a number of other ways that contaminants can affect source water for the Zeba PWS. A detailed list of potential sources of contamination (naturally occurring, agricultural and commercial forestry, residential, municipal, commercial, and industrial sources and processes), which will be updated/tabulated as time and resources are included in the SWPP.

## **ZONING REQUIREMENTS**

All existing zoning ordinances shall apply. As much as practical, given the 98 mi<sup>2</sup> size of the source water area (SWA) and diverse nature of the communities, Keweenaw Bay Indian Community (KBIC) will work with the Villages of L'Anse and Baraga and also Township Governments to insure that any new construction and development that occurs within the SWA, and in particular the 3,000 ft critical assessment zone near the intake, be completed with the health and safety of the source water in mind.

## **REFRESHER AND PUBLIC AWARENESS PROGRAM**

On a regular basis, KBIC Natural Resources Department personnel shall conduct a brief program making all members of the SWPP Group aware of the importance of the SWPP. News bulletins should be aired in local media reminding residents of the importance of being good citizens and watchmen of the SWA.

Refresher courses should address proper handling and disposal of all potentially hazardous materials found in the SWA.

Regular visits should be made to schools and other community functions to remind the public and create an awareness of the importance of Keweenaw Bay water quality to everyday activities in the surrounding communities including Zeba.

## EMERGENCY PROCEDURES

### Notify immediately:

Water Department personnel at KBIC, L'Anse, and Baraga  
KBIC, Arlan Friisvall, Director (906) 353-6623 (ext. 4126)  
Cell (906) 250-3221  
Pager (906) 222-2214  
L'Anse, Water Plant (906) 524-5880 Pumping Station (906) 524-7230  
Baraga, (906) 353-6795 Home (906) 482-7235

KBIC Natural Resources Department: (906) 524-5757

KBIC Tribal Police Department (906) 353-6626, 524-6699

Baraga County Emergency Preparedness Director: (906) 524-7240

Michigan Department of Environmental Quality, Remediation and Redevelopment Division;  
Clif Clark, District Supervisor, Upper Peninsula District, (906) 346-8515

U.S. Environmental Protection Agency: (KBIC) Kelly Jacobs Tribal EPA contact (906) 524-5757, Ext. 15, (EPA) Chuck Pycha, Technical contact (312) 887-0259; Dennis Baker, Michigan Circuit Rider (231) 271-7492

### *Emergency and short-term water supply options*

Option	Technical and logistical feasibility	Reliability	Political considerations	Cost considerations
Bottled water	Easily obtainable	Good, Does not deal with dermal or inhalation exposure, which may still be present in non-potable use water	Good	Variable, price could be negotiated with suppliers
Tank Trucks	Available from National Guard or private milk haulers	Tanks need to be sterile	Good	Variable, low capital investment
Conservation	Requires public education. Important to protect priority demand	Depends on voluntary compliance.	Generally positive, except for groups excluded by priority use restrictions. Does not all water demand	Low
Treatment at wellhead	Not always an option. Treatment technologies may not be readily available, if at all	Contaminant specific	Public confidence in treated water	Variable, can be capital intensive

### *Long-term water supply replacement options*

Option	Technical and logistical feasibility	Reliability	Political considerations	Cost considerations
Develop new intake(s) in uncontaminated area	May be difficult, depends on nature of problem at old intake. Also may require many miles of piping	Good, although subject to similar security problems as current system	May require acquisition of right-a-way	High
Additional treatment on current supply	Not always an option. Depends on nature of problem, contaminant, etc.	Contaminant specific	Public confidence in treated water	Variable, can be capital intensive
Point-of-use treatment	Variety of systems available. Installation may be problematic. May not be useable for specific contaminant	Inadequate performance is possible. Not maintenance free. Does not deal with dermal or inhalation exposure, which may still be present in non-potable use water	Potential conflict over who owns the filters and who does maintenance	Each unit has a fixed cost, plus maintenance cost
Remediation	May not be possible, or may be too expensive in the current funding environment. Developing technology. Depends on degree of contamination	Contaminant specific	May require use of Federal or State Superfund or other clean-up monies	Very expensive in some instances. Can require a long-term commitment of funding and other resources
Interconnection with another system	Two nearest systems will likely also be impacted by same contamination	Good, if contamination is confined to Zeba intake only	Will require Tribe to purchase water from a municipal source, loss of autonomy	High, capital intensive and may require increased rates to customers

## **Appendix 6**

### **Process for Completing the Inventory of Permitted and Known Potential Contaminant Sources**

## **Process for Completing the Inventory of Permitted and Known Potential Contaminant Sources**

The process for completing the inventory included several steps, which are summarized as follows:

1. Reviewed readily available land use maps and historical/current aerial photographs.
  5. Plotted relevant information from applicable state and federal regulatory databases including the following lists:
    - MDEQ leaking underground storage tank (LUST) sites
    - MDEQ registered underground storage tank (UST) sites
    - MDEQ Environmental Cleanup Site Information System (ECSI) sites; MDEQ Source Information System (for water discharge permit sites including National Pollutant Discharge Elimination System (NPDES) permits, Water Pollution Control Facility (WPCF) permits, storm water discharge permits, and on-site sewage (septic) system permits)
    - MDEQ Underground Injection Control (UIC) database
    - MDEQ Active Solid Waste Disposal Permits list
    - Michigan Department of Transportation (MDOT) - Hazardous Materials database
    - State Fire Marshall registry of above-ground fuel storage tank sites
    - State Fire Marshall Hazardous Material Handlers and Hazardous Material Incidents (HAZMAT) sites
    - U.S. EPA BASINS software, version 2.1
    - U.S. EPA Envirofacts database
    - U.S. EPA Resource Conservation Recovery Act (RCRA) generators or notifiers list
    - U.S. EPA RCRA Treatment, Storage, and Disposal Facility (TSDF) Permits list
    - U.S. EPA National Priorities List (NPL)
    - U.S. EPA Comprehensive Environmental Response, Compensation and Liability Information System (CERCLA) List;
    - U.S. EPA RCRA Corrective Action Activity List (CORRACTS)
    - U.S. Department of Transportation (DOT) Hazardous Materials Information Reporting System (HMIRS)
    - U.S. EPA Toxic Chemical Release Inventory System (TRIS)
    - U.S. EPA Oil Pollution Act of 1990 Spill Response Atlas
  6. Met with public water supply and IHS officials by phone during September and October, 2001, to identify potential sources not listed elsewhere in databases or on maps, and completed a preliminary inventory form used to compile the SWA base map. Conducted subsequent contacts by email and telephone on numerous occasions to request additional data, clarify data, and discuss results.
  7. Land use and/or ownership (for example, residential/municipal; commercial/industrial; agricultural/forest; and other land uses) was mapped and evaluated in relation to PCS, soil characteristics, and proximity to the intake.
- Completed final inventory form of PCS and plotted locations of PCS on the base map.